Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L26	232	372/49.01.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 09:39
L27	32	L26 and (vcsel or "surface emitting" or "surface-emitting")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 11:31
L28	1	("5328854").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2005/12/13 10:05
L29	0	2000jp-0117973.ap,prai.	US-PGPUB; USPAT; USOCR	OR	ON	2005/12/13 10:06
L30	0	("2000jp-0117973.ap,prai.").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/12/13 10:06
L31	0	("2000jp-0306804.ap,prai.").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/12/13 10:06
L32	0	("2000JP-0306804.ap,prai.").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/12/13 10:06
L33	1	2000JP-0306804.ap,prai.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 10:37
L34	1	2000JP-0117973.ap,prai.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 10:37
L35	1	("5328854").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2005/12/13 11:30
L36	3115	372/45.01,46.01,46.013,46.015.ccls.	US-PGPUB; USPAT; USOCR	OR	ON	2005/12/13 11:30

L37	717	L36 and (vcsel or "surface emitting" or "surface-emitting")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 14:12
L38	18	L37 and (electrode and (sion or (silicon near oxide near nitride)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 14:12
L39	11	("20010050934" | "4908686" | "5245622" | "5424559" | "5557627" | "5936266" | "5960018" | "5978398" | "6052398" | "6061380" | "6618410").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2005/12/13 11:50
L40	116	"372".clas. and (protective with (film or layer or coating) with electrode)	US-PGPUB; USPAT; USOCR	OR	ON	2005/12/13 11:51
L41	2271	"372".clas. and (vcsel or "surface emitting" or "surface-emitting")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 14:12
L42	55	L41 and (electrode and (sion or (silicon near oxide near nitride)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 14:12
L43	37	L42 not L38	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 14:25
L44	36	"372".clas. and (fuji.as. and protective)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/13 14:26
L45	2	("5563422").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/12/13 14:50

ETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the field luminescence semiconductor laser used for an optical interconnection, and optical exchange and optical information processing, and its manufacture approach.
[0002]
[Description of the Prior Art] In recent years, research of the optical interconnection which aimed at the fast improvement in transmission speed as a means of signal transduction of a logic element is advanced. the field luminescence laser (Vertical -- "VCSEL" is called suitably below Cavity Surface Emitting Laser diode:.) which can be arranged to high density by two-dimensional attracts attention in the light emitting device as the juxtaposition light source. About VCSEL, pioneering research is made by Iga and others and it is collected into the 27th volume (IEEE Journal of QuantumElectronics) (p. 1332) of the IEEE journal OBUKANTAMU electronics of issue in 1988.
[0003] The latest VCSEL simple substance consists of structures shown in drawing 8 . That is, a resonator 302 is perpendicularly formed to the horizontal plane of the semi-conductor substrate 301, and this resonator 302 consists of the barrier layer 303 which a carrier is shut [barrier layer] up and generates light, the lower reflective mirror 304 which consists of semi-conductor multilayers, an up reflecting mirror mirror 305 which consists of semi-conductor multilayers, and a spacer layer 306 which adjusts the phase of the light which emitted light by the barrier layer at the edge of the both semi-conductors multilayers reflective mirror of said upper part and lower part. As a component besides a resonator, it comes to prepare the up electrode 308 having the function of the up contact layer 307 and outgoing radiation opening of laser, an interlayer insulation film 310, and the lower electrode 309.
[0004] In order to carry out laser oscillation, a carrier and light need to close also to the horizontal direction (namely, direction parallel to the flat surface containing this substrate) of a substrate 301, and it is necessary to perform eye **. As a means to produce the constriction structure in a substrate 301 and a horizontal direction About ten-micron thin pillar-shaped (post) structure is produced by dry etching. How to insulation-ize a part of AlAs oxidizing zone by steam oxidation, and limit a current path, after producing the approach (simple post mold) of making said postsection itself a current path, and said poststructure (AlAs oxidation type), There is the approach (proton in plastic mold) of forming an insulating region by PUROTONIMPURA and limiting a current path etc. It is known that, as for current, VCSEL which was low and was excellent in the current-light property can also produce a threshold current value by said AlAs oxidation (an application electronic physical-properties subcommittee magazine, 5th volume ** No. 1, 1999, p.11). 312 in drawing 8 is an AlAs layer, and the field where the field expressed with 312A is expressed with an oxidation field and 312B is a non-oxidizing field. Opening 313 is formed in the up electrode 308, and it becomes a laser beam window.
[0005] However, it turned out that there are the following problems at the above-mentioned conventional VCSEL. That is, it is dependability is remarkable and low -- the optical output of that contact resistance of the up electrode 308 is strong in the first place and the second device declines gradually with energization. It turned out that it originates in the two above-mentioned problems having the thickness of a GaAs contact layer as thin as a number - about 10nm of numbers.
[0006] That is, although referred to as 50nm - hundreds of nm as thickness of the GaAs contact layer which is the maximum surface of the substrate with which the up electrode has usually touched in VCSEL with end-face luminescence laser and wavelength long 850nm, if a thick GaAs contact layer is taken in the 780nm band VCSEL etc. and short wavelength regions VCSEL, the light absorption in the layer will become large, and a threshold current value will be increased remarkably. Therefore, in order to suppress light absorption and to consider as a practical property, thickness of a GaAs contact layer is made small with a number - about 10nm of numbers.
[0007] On the other hand, in the phase in the middle of producing VCSEL, the GaAs contact layer which is this maximum surface is put to various process environments, and tends to receive a damage.

For example, although the process which carries out film deposition of the SiON film etc. with a CVD method goes into a GaAs contact layer front face several times, the desorption of As is promoted from a GaAs surface by plasma gas and the heat history of CVD at this time, GaAs with a depth of dozens of nm deteriorates from a surface in the layer in which stoichiometry collapsed, or a crystal defect is generated. In a subsequent contact hole formation process, this GaAs deterioration layer is put to buffered fluoric acid. Usually, although GaAs is not easily etched by buffered fluoric acid, this GaAs deterioration layer will be etched. Here, although what is necessary is just to be able to delete the 10nm of the surface number of the layers which received the damage when a GaAs contact layer is as thick as about 100nm, from the first, dozens of nm and when thin, all GaAs contact layers will be etched for a contact layer like 780nm band, and it will disappear, and the lower layer AlGaAs layer will be exposed.
[0008] If an up electrode is formed in the AlGaAs layer front face which the GaAs contact layer disappeared and appeared, contact resistance will increase and the driver voltage of a device will become high. moreover, although opening of an up electrode serves as optical outgoing radiation opening, since the front face of the outgoing radiation opening is set to AlGaAs, it reacts with the oxygen in atmospheric air, and moisture, and AlGaAs oxidizes and black-izes (this -- the melanism of AlGaAs -- it is called a phenomenon.). this melanism -- especially a phenomenon advances rapidly by energizing. Consequently, the laser beam which should be carried out outgoing radiation from outgoing radiation opening is absorbed by the AlGaAs oxidizing zone in which the surface carried out melanism, and the fall of an optical output arises.
[0009] Usually, disappearance of a GaAs contact layer can be prevented by thickening a GaAs contact layer, but on the other hand light absorption increases. Moreover, the result which GaAs can be deleted [result], and GaAs thickness separates [result] from a design value, and reduces the reflection factor of a reflecting mirror after passing through a process, consequently increases the threshold current value of a device is caused.
[0010] In addition to the two above-mentioned problems, the GaAs contact layer was also found by that the above-mentioned conventional VCSEL is etched with the resist developer used in the photolithography process at the time of contact electrode formation as the third problem. That is, as above-mentioned, thickness of the GaAs contact layer is carried out, and thickness of a GaAs contact layer is made small with a number - about 10nm of numbers in the short wavelength regions VCSEL, such as the 780nm band VCSEL, in consideration of the point of the light absorption in this layer becoming large, and increasing a threshold current value remarkably to a case. However, production of the contact electrode of VCSEL which uses Au for an electrode metal forms the resist of a negative pattern, and usually forms an electrode metal in many cases by the approach of carrying out lift off of these after film deposition. In this case, since the GaAs contact layer 401 touches a resist developer directly as shown in drawing 28 , it will be etched with this developer (sign 404 in drawing). the case of previous statement -- the same -- case especially a GaAs contact layer is very as thin as dozens of nm -- development conditions -- the GaAs contact layer 401 -- all are etched, it disappears and lower layer AlGaAs402 is exposed. Although AlGaAs is not completely exposed, the thickness of a GaAs contact layer will differ for every batch processing.
[0011] When this GaAs contact layer forms the contact electrode 405 in the AlGaAs layer front face which disappeared and appeared, contact resistance will increase and the driver voltage of a device will become high. Moreover, since the thickness of the residual membrane changes with samples when GaAs remains in the ultra-thin film, the variation in the electrode characteristic is produced.
[0012] On the other hand, the part near the electrode metal of the opening 406 of a contact electrode is a field which are not covered by the resist, and a developer will actually touch and will be etched. thus, the part in the electrode opening 406 -- if GaAs of a field 407 is etched, in a subsequent process, it is easy to receive conversion, and surface etching will advance or the inside of opening will oxidize. after [and] a device is completed -- the oxygen in atmospheric air, and moisture -- reacting -- oxidation of AlGaAs -- going on -- the melanism of the same AlGaAs as the above -- a phenomenon is induced. the melanism in said outgoing radiation opening -- if a phenomenon happens, as a result of absorbing the laser beam which should be carried out outgoing radiation from outgoing radiation opening on the outgoing

radiation opening surface which carried out melanism, the fall of an optical output is caused.
[0013] As mentioned above, even if contact layers are dozens of nm and the thin short wavelength region VCSEL from the first, the 780nm band VCSEL etc. Increase of the contact resistance by the damage on pervasion of a contact layer, disappearance, etc. which consists of GaAs, the variation in the electrode characteristic, and melanism -- the present condition is that the reliable field luminescence semiconductor laser equipment of a perpendicular resonator mold which avoids a phenomenon, has the property stabilized in low resistance, and may discover the laser beam of the high power which does not decline with time amount is not yet offered.
[Problem(s) to be Solved by the Invention] This invention solves many problems in said former, and makes it a technical problem to attain the following purposes. Namely, it is low resistance, and high power is obtained, and this invention aims at offering the field luminescence semiconductor laser equipment of a reliable perpendicular resonator mold which may discover a laser beam without the loss of power in the passage of time to stability. This invention aims at offering the manufacture approach of the field luminescence semiconductor laser equipment which can produce the field luminescence semiconductor laser equipment of a perpendicular resonator mold with the high dependability which can maintain a laser output to high power and stability.
[0014]
[Means for Solving the Problem] The result to which this invention person etc. repeated examination wholeheartedly about the technique in which stabilization of the laser output of a short wavelength region VCSEL can be realized, The contact layer located in opening (laser beam window) which carries out outgoing radiation of the laser into the manufacture process of equipment itself as above-mentioned receives damage. The knowledge that stabilization of laser could not be desired only by avoiding the damage received from this damage influencing the reinforcement of a laser output and stabilization at the time of the use after manufacture process termination was acquired.
[0015] Said The means for solving a technical problem is as follows. Namely, <1> It is perpendicular resonator mold face luminescence semiconductor-laser equipment characterized by to be covered by the protective coat for said opening to prevent the damage on on the manufacture after said contact electrode formation on a semi-conductor substrate in the perpendicular resonator mold face luminescence semiconductor-laser equipment which equips this order with the semi-conductor multilayers reflecting mirror of the first conductivity type, a barrier layer, the semi-conductor multilayers reflecting mirror of the second conductivity type, and the contact electrode that has opening which carries out outgoing radiation of the laser beam.
[0016] <2> The surface area of a protective coat is smaller than the area of the contact electrode containing opening, and is perpendicular resonator mold face luminescence semiconductor laser equipment given in the larger above <1> than the area of opening.
<3> It is perpendicular resonator mold face luminescence semiconductor laser equipment the above <1> with which the wiring electrode was arranged in the location which is joined to a contact electrode and laps on a protective coat, or given in <2>.
[0017] <4> It is perpendicular resonator mold face luminescence semiconductor laser equipment equipped with the semi-conductor multilayers reflecting mirror of the first conductivity type, a barrier layer, the semi-conductor multilayers reflecting mirror of the second conductivity type, a protective coat, and the contact electrode that has opening which carries out outgoing radiation of the laser beam on a semi-conductor substrate, and is perpendicular resonator mold face luminescence semiconductor-laser equipment characterized by being prepared so that said contact electrode may lap on a protective coat, and forming said opening on this protective layer.
[0018] <5> It is perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <1>- <4> which is located in the lower layer of this protective coat, and is equipped with the contact layer of a conductivity type between the semi-conductor multilayers reflecting mirror of the second conductivity type, and a contact electrode seen from the thickness direction of a protective coat.
[0019] <6> Finally two or more structures are arranged on the semi-conductor multilayers reflecting

mirror of the second conductivity type, or a contact layer. A contact electrode among these structures seen from the thickness direction of the semi-conductor multilayers reflecting mirror of the second conductivity type It is arranged as the lowest layer on the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer. A contact electrode is perpendicular resonator mold face luminescence semiconductor laser equipment the above <1> which is the first structure formed before one which is finally arranged on the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer of other structures, or given in <5>.

[0020] <7> The field (contact hole) in which an insulator layer is prepared on the field in which the protective coat is not formed, or a contact layer, and both this insulator layer and a protective coat are not formed is perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <1>- <6> covered with the contact electrode.

[0021] <8> the semi-conductor multilayers reflecting mirror of the second conductivity type or a contact layer, and the abbreviation for the side which does not counter -- it is perpendicular resonator mold face luminescence semiconductor-laser equipment given in either of aforementioned <1>- <7> in the range in which the thickness of the protective coat in a flat field is located in the upper layer of a barrier layer and in which the reflection factor of the light in the laser wavelength of the reflector containing the second semi-conductor multilayers reflecting mirror and protective coat of a conductivity type serves as the abbreviation maximum.

[0022] <9> Opening of a contact electrode is perpendicular resonator mold face luminescence semiconductor laser equipment given in either of the upper parts of a flat field or abbreviation aforementioned [which is formed caudad] <1> - <8> of said semi-conductor multilayers reflecting mirror or a contact layer, and the protective coat of the side which does not counter seen from the thickness direction of the protective coat formed in either the semi-conductor multilayers reflecting mirror of the second conductivity type, and the contact layer.

[0023] <10> The protective coat formed on either the semi-conductor multilayers reflecting mirror of the second conductivity type and the contact layer It comes to have a flat field and an inclination field. the side which does not contact said semi-conductor multilayers reflecting mirror or a contact layer -- abbreviation -- Or opening of a contact electrode is formed caudad. in view of the thickness direction of a protective coat -- said abbreviation -- the upper part of a flat field and an inclination field -- and abbreviation -- the thickness of the protective coat in a flat field is located in the upper layer of a barrier layer -- The reflection factor of the light in the laser wavelength of the reflector containing the second semi-conductor multilayers reflecting mirror and protective coat of a conductivity type is perpendicular resonator mold face luminescence semiconductor laser equipment given in either of said abbreviation aforementioned [in the range which serves as max in a flat field] <1> - <9>.

[0024] <11> A protective coat is perpendicular resonator mold face luminescence mold semiconductor laser equipment given in either of aforementioned <1>- <10> which is either which is chosen from SiO2 film, the SiOxNy film, the SiNx film, and the InxSnyOz film.

[0025] <12> On a semi-conductor substrate, the semi-conductor multilayers reflecting mirror of the first conductivity type, In the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment of having the process which forms in this order a barrier layer, the semi-conductor multilayers reflecting mirror of the second conductivity type, and the contact electrode that has opening which carries out outgoing radiation of the laser beam It is the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment characterized by covering this opening by the protective coat at least immediately after forming the contact electrode which has said opening.

[0026] <13> On a semi-conductor substrate, the semi-conductor multilayers reflecting mirror of the first conductivity type, In the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment of having the process which forms in this order a barrier layer, the semi-conductor multilayers reflecting mirror of the second conductivity type, and the contact electrode that has opening which carries out outgoing radiation of the laser beam According to the process at which said contact electrode differs from formation of the wiring electrode joined to this contact electrode

Carry out film deposition of the sacrifice layer on said contact layer, and on this sacrifice layer, prepare the resist mask for lift off and said sacrifice layer is etched with this resist mask. Where said resist mask is prepared, after carrying out film deposition of the electrode material further, it is the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment characterized by carrying out lift off of said resist mask, and being formed.
[0027] <14> A sacrifice layer is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in the above <13> which is either which is chosen from the SiON film, the SiNx film, SiO2 film, the InxSnyOz film, and the SOG film.
<15> A sacrifice layer is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment the above <13> which is the SOG (annealing was carried out for hardening) film by which the cure was carried out below 250 degrees C, or given in <14>.
<16> A sacrifice layer is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment the above <14> by which film deposition is carried out by the sputtering method, or given in <15>.
<17> The thickness of a sacrifice layer is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <13>- <16> which is 0.05-0.3 micrometers.
[0028] <18> On a semi-conductor substrate, the semi-conductor multilayers reflecting mirror of the first conductivity type, In the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment of having the process which forms in this order a barrier layer, the semi-conductor multilayers reflecting mirror of the second conductivity type, a protective coat, and the contact electrode that has opening which carries out outgoing radiation of the laser beam It is the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment characterized by forming the protective coat formative layer which forms a protective coat before configuration processing of the semi-conductor multilayers reflecting mirror of said second conductivity type, and formation of a contact electrode.
[0029] <19> It is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <12>- <18> by which the contact layer of a conductivity type is formed on the semi-conductor multilayers reflecting mirror of the second conductivity type before formation of a protective coat and a contact electrode.
<20> Finally two or more structures are arranged on the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer. A contact electrode is formed before which the structure of the others finally arranged at either on the semi-conductor multilayers reflecting mirror of the second conductivity type, and a contact layer. It is the manufacture approach of either of aforementioned <12>- <17> in which it joins to this contact electrode and a wiring electrode is formed, or perpendicular resonator mold face luminescence semiconductor laser equipment given in the above <19> after formation of a contact electrode.
[0030] <21> After carrying out laminating formation of the covering film with which a protective coat consists of an ingredient which can be etched alternatively to the protective coat formative layer and the protective coat which form a protective coat, it is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <12>- <20> etched and formed.
<22> In the process after the protective coat was formed, the covering film which covers the front face of either the semi-conductor multilayers reflecting mirror of the second conductivity type which has a protective coat, and a contact layer is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <12>- <21> alternatively formed to a protective coat with the ingredient which can be etched.
[0031] <23> A protective coat consists of either SiO2 film, SiOxNy film and SiNx film, and it is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in the above <22> whose ingredient which can be etched is the InxSnyOz film.
<24> After a contact electrode forms and processes the protective coat formative layer which forms a

protective coat and either the semi-conductor multilayers reflecting mirror of the second conductivity type and a contact layer are exposed, it is the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment given in either of aforementioned <18>- <23> formed in this exposed part.
[0032] Hereafter, each operation of each perpendicular resonator mold face luminescence semiconductor laser equipment and its manufacture approach of a publication is explained to aforementioned <1>- <22>. According to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <1>, at a separately different process from the wiring electrode which carries out current supply Since the electrode (contact electrode) joined to the semi-conductor multilayers reflecting mirror of the second conductivity type has opening for laser outgoing radiation, it has it and this opening is further covered with a protective layer The whole surface of the semi-conductor multilayers reflecting mirror of the second conductivity type can be protected from the effect are influenced by the exterior in the middle of the use process after production, and a production process. That is, it exists separately, and through this contact electrode, current supply is carried out and the protective coat formation of a wiring electrode and a contact electrode by the initial stage of a process is attained at the semi-conductor multilayers reflecting mirror of the second conductivity type connection and by on the other hand having the protective coat by which patterning was carried out.
[0033] the melanism accompanied by the fall of a laser output by increase of the contact resistance by the damage on pervasion of the front face of the semi-conductor multilayers reflecting mirror of the second conductivity type, disappearance, etc. which consists of GaAs by considering as this configuration, and the black discoloration color -- a phenomenon can be avoided, it has the property stabilized in low resistance, and stability can be made to discover the laser beam of the high power which does not decline with time amount Therefore, the supply by which the reliable device was stabilized is attained.
[0034] Since according to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <2> a protective coat is prepared so that the surface area may become larger than the area of opening smaller than the area of the contact electrode containing opening, a protective coat can be prepared in the initial stage of a manufacture process.
[0035] According to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <3>, after a contact electrode and a protective coat are prepared at least, the wiring electrode joined to a contact electrode is arranged.
[0036] According to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <4>, it can protect from the effect of the semi-conductor multilayers reflecting mirror of the second conductivity type which receives the outgoing radiation field of laser from the exterior at least in the middle of the use process after production, and a production process. namely, the melanism accompanied by the fall of a laser output by increase of the contact resistance by the damage on pervasion of the semi-conductor multilayers reflecting mirror of the second conductivity type exposed by considering as this configuration, disappearance, etc., and the black discoloration color -- a phenomenon can be avoided, it has the property stabilized in low resistance, and stability can be made to discover the laser beam of the high power which does not decline with time amount Therefore, adequate supply of a reliable device is possible.
[0037] Since a contact layer is prepared on the semi-conductor multilayers reflecting mirror of the second conductivity type according to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <5> Although the contact resistance in connection between the semi-conductor multilayers reflecting mirror of the second conductivity type, a contact layer, and a contact electrode can be reduced effectively Even if it is this case, are based on the damage on pervasion of this contact layer, disappearance, etc. the melanism accompanied by the fall of a laser output by increase of contact resistance, and the black discoloration color -- a phenomenon can be avoided, it has the property stabilized in low resistance, and stability can be made to discover the laser beam of the high power which does not decline with time amount Therefore, a contact layer is prepared, and originally, even if it is the case of the short wavelength regions VCSEL, such as the thin 780nm

wavelength range VCSEL of the thickness of a contact layer, it can supply as a reliable device.
[0038] Although two or more structures including the wiring electrode which finally carries out current supply are especially formed on a contact layer by considering as the configuration of a publication the above <6> or <7> Since the contact electrode of these structures is prepared as the structure (the first structure) of the ** point Since it can cover with a contact electrode beforehand so that the second semi-conductor multilayers reflecting mirror or contact layer of a conductivity type may not be exposed as the maximum surface, damage on a contact layer can be prevented effectively.
[0039] According to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <8> The interior of the reflector which contains the contact layer and the second semi-conductor multilayers reflecting mirror in this protective layer and its lower layer even if a protective coat is formed in the laser outgoing radiation section, Decline in the reflection factor of the laser beam oscillated on specific wavelength (about 780nm) can be prevented, and the perpendicular resonator mold face luminescence semiconductor laser equipment which may discover the laser of high power can be produced to stability.
[0040] According to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <9> The field where the field (opening) which carries out outgoing radiation of the laser does not counter with the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer and where a near protective coat is flat, Namely, it is the side which does not contact the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer. this semi-conductor multilayers reflecting mirror or a contact layer, and abbreviation, since it is prepared only in the upper part (for example, opening 113 of drawing 17) of the parallel front face to expose, or the lower part (for example, drawing 1) this -- the reflection factor of the light in a reflector can be highly maintained easily and stably by the thickness control of a flat field, and stabilization of the oscillation nature of a laser beam and a high increase in power can be attained.
[0041] while according to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <10> a reflection factor is low and the thickness of a protective coat becomes thick in an inclination (taper) field -- a reflection factor -- large -- becoming -- abbreviation -- since it becomes max in a flat surface field, the waveguide of the longitudinal direction of laser can be substantially narrowed rather than opening of a contact electrode. Moreover, a desired beam diameter and oscillation mode can be chosen by controlling the taper angle and configuration of a taper field suitably.
[0042] According to the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <11>, a protective coat can be easily formed by the physical well-known film deposition approaches, such as the sputtering method and a CVD method. And by the sputtering method, the damage (damage) done to the second semi-conductor multilayers reflecting mirror or contact layer of a conductivity type which a front face becomes from GaAs can be reduced as much as possible.
[0043] According to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <12> Immediately after [forming a contact electrode on the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer], On a semi-conductor substrate, at least Namely, the first semi-conductor multilayers reflecting mirror, a barrier layer, It is, after carrying out laminating formation of the second semi-conductor multilayers reflecting mirror and contact electrode. The inside of two or more structures finally formed on the semi-conductor multilayers reflecting mirror of the second conductivity type, Since a subsequent process is completed without forming a protective coat and moreover removing this protective coat completely, before which the structure of the others except the below-mentioned sacrifice layer is formed The damage on pervasion of a contact layer, disappearance, etc. especially received by the morphosis of an insulator layer, the morphosis of a contact hole, etc. can be prevented in the middle of a production process.
[0044] Consequently, increase of contact resistance and the fall of the laser output in the black discoloration color (melanism phenomenon) of outgoing radiation opening can be avoided, it has the

property stabilized in low resistance, and the perpendicular resonator mold face luminescence semiconductor laser equipment (it may be hereafter called a "device") which may discover to stability the laser beam of the high power which does not decline with time amount can be manufactured to stability. Improvement in the dependability of the short wavelength region VCSEL equipped with thin film contact layers, such as the 780nm wavelength range VCSEL, is realizable.

[0045] According to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <13> Follow on the damage on pervasion of the semi-conductor multilayers reflecting mirror of the second conductivity type, disappearance, etc. received by contact to the developer used especially at the time of resist development in the middle of a production process. the melanism accompanied by the fall of a laser output by increase of contact resistance, the variation of the electrode characteristic, and the black discoloration color -- a phenomenon is avoided, it has the property stabilized in low resistance, and the device which may discover to stability the laser beam of the high power which does not decline with time amount can be manufactured more to stability. Improvement in the dependability of the short wavelength region VCSEL equipped with thin film contact layers, such as the 780nm wavelength range VCSEL, is realizable like the above <12>.

[0046] According to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <14>, a sacrifice layer can be easily formed like the case of the above <11> by the physical well-known film deposition approaches, such as the sputtering method and a CVD method. On the other hand, if the SOG film is used as a sacrifice layer, the well-known method of application can be used and even the plasma damage which goes into a contact layer slightly under low temperature 250 degrees C or less after spreading at the time of a cure, i.e., the film deposition by the spatter since it can form simply only by carrying out annealing treatment and making it harden, can be avoided. Moreover, the InxSnyOz film is alternatively useful by dilute hydrochloric acid to a contact layer at the point which can be etched.

[0047] According to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <15>, since curing temperature is low temperature 250 degrees C or less as stated above, oxidation of the front face of the semi-conductor multilayers reflecting mirror of the second conductivity type can also be controlled, and the effectiveness which can form contact resistance into low resistance more can also be expected.

[0048] According to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <16>, by the film deposition by the sputtering method, since there is little effect on GaAs, the damage (damage) done to the contact layer which consists of GaAs can be reduced as much as possible, and the effectiveness of this invention can be raised more.

[0049] Since the reflection factor in the total thickness of the laser beam oscillated on the specific wavelength of the reflector which doubled the semi-conductor multilayers reflecting mirror and the sacrifice layer with the range given in the above <17> by adjusting thickness is highly maintainable, outgoing radiation of the laser beam of high power can be carried out. moreover, a part of inside of a production process, and sacrifice layer -- the film deposition of a contact electrode and lift off can be completed, without inducing the failure by the resist at the time of etching. Consequently, it becomes producible [a highly precise device] and the yield may also be raised.

[0050] Since according to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <18> a protective coat is prepared and it is protected in the first place to the outgoing radiation field of laser Follow on the damage on pervasion of the semi-conductor multilayers reflecting mirror of the second conductivity type, disappearance, etc. received like the above <12> and <13> by contact to the developer used especially at the time of resist development in the middle of a production process. the melanism accompanied by the fall of a laser output by increase of contact resistance, the variation of the electrode characteristic, and the black discoloration color -- a phenomenon is avoided, it has the property stabilized in low resistance, and the device which may discover to stability the laser beam of the high

power which does not decline with time amount can be manufactured more to stability.
[0051] Since a contact layer is prepared on the semi-conductor multilayers reflecting mirror of the second conductivity type according to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <19> Although the reflection factor in the reflecting mirror which comes to contain the second semi-conductor multilayers reflecting mirror, contact layer, and protective coat of a conductivity type can be raised effectively Since a protective coat is prepared and it is protected in the first place to the outgoing radiation field of the laser on said contact layer even if it is this case Increase of the contact resistance by the damage on pervasion of this contact layer, disappearance, etc., the melanism accompanied by the fall of a laser output by the black discoloration color -- a phenomenon can be avoided, it has the property stabilized in low resistance, and the device which may discover to stability the laser beam of the high power which does not decline with time amount can be manufactured more to stability. Therefore, a contact layer is prepared and, originally, also in the case of the short wavelength regions [, such as the thin 780nm wavelength range VCSEL of the thickness of a contact layer,] VCSEL, a reliable device can be manufactured.
[0052] Since the wiring electrode connected with a contact electrode is formed at the process that the contact electrode after formation of a contact electrode is separate according to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <20>, the second semi-conductor multilayers reflecting mirror or contact layer of a conductivity type is covered with a contact electrode, and also bears the function as a protective layer.
[0053] Since the laminating of the covering film (mask for etching) which consists of an ingredient with which the protective coat finally arranged differs from etch selectivity is carried out with a protective coat according to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <21> Even if it has not formed a contact electrode, configuration processing can be carried out at poststructure, without damaging the exposure of the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer. And the semi-conductor multilayers reflecting mirror exposed in a contact hole or a contact layer can be made to be able to contact directly, a wiring electrode can be formed, and a contact electrode can be made to have.
[0054] Since the covering film temporarily prepared as a mask etc. on a protective coat consists of an ingredient with which a protective coat differs from etch selectivity according to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <22>, etching processing can be easily carried out using the difference in an etch rate.
[0055] Since according to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <23> a protective coat consists of SiO2 film, SiOxNy film, or SiNx film and the covering film formed on a protective coat of InxSnyOz from which this film and an etch rate differ is constituted, based on the difference in an etch rate, etching processing can be performed easily alternatively.
[0056] According to the manufacture approach of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention given in the above <24> A contact electrode is prepared as the structure of the beginning after it forms and processes the protective coat formative layer which forms a protective coat and either the semi-conductor multilayers reflecting mirror of the second conductivity type and a contact layer are exposed. That is, since the protective coat of the structures is prepared as the structure (the first structure) of the ** point and can cover the outgoing radiation field of laser with a protective coat beforehand, damage on the semi-conductor multilayers reflecting mirror of the second conductivity type especially in an outgoing radiation field or a contact layer can be prevented effectively.
[0057]
[Embodiment of the Invention] In the perpendicular resonator mold face luminescence semiconductor

laser equipment of the first mode of this invention, the front face of the semi-conductor multilayers reflecting mirror of the second conductivity type or a contact layer is equipped with the contact electrode which has opening which has this front face in an exposure, and even if there are few these contact electrodes, a protective coat is prepared in opening. In the perpendicular resonator mold face luminescence semiconductor laser equipment of the second mode of this invention, a contact electrode is prepared so that it may lap on the front face of the protective coat formed on the semi-conductor multilayers reflecting mirror of the second conductivity type, or the contact layer, and it comes to form said opening only on this protective layer.

[0058] the first voice of this invention -- a subsequent process is completed in the manufacture approach of perpendicular resonance mold face luminescence semiconductor laser equipment [like], without covering completely said opening which a contact layer exposes by the protective coat, and removing this protective coat completely immediately after forming in the front face of the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer the contact electrode which has opening. Furthermore, in a different process from formation of the wiring electrode joined to this contact electrode, after preparing the resist mask for lift off on the sacrifice layer by which film deposition was carried out on said contact layer, etching said sacrifice layer with this resist mask and carrying out film deposition of the electrode material further in this condition, said contact electrode carries out lift off of said resist mask, and is formed. In the manufacture approach of the perpendicular resonance mold face luminescence semiconductor laser equipment of the second mode of this invention, it is after formation of the semi-conductor multilayers reflecting mirror of the second conductivity type, and a protective coat is formed before configuration processing of this semi-conductor multilayers reflecting mirror and formation of a contact electrode. Hereafter, the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention and its manufacture approach are explained.

[0059] <Perpendicular resonator mold face luminescence semiconductor laser equipment> The perpendicular resonator mold face luminescence semiconductor laser equipment of this invention concerning the first mode is explained first. The perpendicular resonator mold face luminescence semiconductor laser equipment of said first mode On the front face of a semi-conductor substrate, at least The first semi-conductor multilayers reflecting mirror, A barrier layer, the second semi-conductor multilayers reflecting mirror, and the basic structure that the contact layer deposited in this order if needed, That is, it has a perpendicular resonator part, and the contact electrode and laser beam window which have a laser beam window (opening) on said second semi-conductor multilayers reflecting mirror or a contact layer are further had and constituted in the structures, such as a wrap protective coat, an insulator layer, and a wiring electrode. When it is not necessary to necessarily prepare when the second semi-conductor multilayers reflecting mirror also has the function of a contact layer, and it does not have the function of a contact layer conversely, as for said contact layer, it is desirable to prepare a contact layer in that contact resistance is reduced.

[0060] Said perpendicular resonator part For example, the reflecting mirror 304 which consists of the first semi-conductor multilayers at least on the front face of the side in which this lower electrode of the semi-conductor substrate 301 which has the lower electrode 309 is not prepared like drawing 8 (lower reflective mirror), You may come to carry out the laminating of the spacer layer 306, a barrier layer 303, the AlAs layer 312, the reflecting mirror (up reflective mirror) 305 that consists of the second semi-conductor multilayers, and the contact layer 307 to this order. Drawing 8 is the block diagram showing conventional perpendicular resonator mold face luminescence semiconductor laser equipment. The same is said of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention concerning the second below-mentioned mode.

[0061] Here, in this invention, the contact electrode which has opening is formed on the second semi-conductor multilayers reflecting mirror or a contact layer, and before other structures finally arranged on a contact electrode immediately after that are formed (initial stage of a process), a protective coat is prepared so that said whole opening may be covered. As for this protective coat, it is desirable to be prepared as the lowest layer on the second semi-conductor multilayers reflecting mirror or a contact

layer.
[0062] Although it connects with the wiring electrode formed through the insulator layer between the second semi-conductor multilayers reflecting mirror or a contact layer, if it is going to form a contact electrode in a wiring electrode and one, said contact electrode joined to the second semi-conductor multilayers reflecting mirror or a contact layer needs to form the structures, such as an electrode, before it protects the second semi-conductor multilayers reflecting mirror or contact layer, and cannot avoid damage on a contact layer. Therefore, a contact electrode is formed apart from the process which forms a wiring electrode, and a contact electrode is made to have both the functions as an electrode and a protective layer immediately after forming a contact layer.
[0063] Moreover, since a contact electrode has opening which carries out outgoing radiation of the laser beam and is prepared on the second semi-conductor multilayers reflecting mirror or a contact layer, the opening field in which the contact electrode is not formed will be in the condition that the second semi-conductor multilayers reflecting mirror or contact layer was exposed, and will tend to receive the damage on pervasion, disappearance, etc. in the process after this stratification. Therefore, damage on the contact layer which prepares a protective coat in said opening field by stages in the middle of an equipment production process, and is produced in the manufacture process after the contact stratification is prevented. And the protective coat formation by the initial stage of all manufacture processes is attained, without causing trouble to formation of other structures, since the protective coat by which patterning was carried out is adopted as a protective coat. About the concrete manufacture approach, it mentions later. In addition, the same is said of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention concerning the second below-mentioned mode.
[0064] As long as opening is the mode which is not exposed completely as physical relationship with said protective coat, the second semi-conductor multilayers reflecting mirror, or a contact electrode, you may consist of which modes, you may be formed in the same path as opening so that only opening of a contact electrode may be plugged up, it has a part [major diameter / opening], and it may be formed so that the whole opening may be covered and put. For example, it may be prepared in the mode as shown in drawing 1 . Drawing 1 is the block diagram showing an example of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention concerning this mode.
[0065] The perpendicular resonator mold face luminescence semiconductor laser equipment shown by drawing 1 is constituted as follows. On the front face of the side in which this lower electrode of the semi-conductor substrate 101 which has the lower electrode 112 is not prepared, at least Namely, the semi-conductor multilayers reflecting mirror 102 of the first conductivity type, The spacer layer 105 prepared on this reflecting mirror 102 is minded. A barrier layer 103, The laminating of the second semi-conductor multilayers reflecting mirror 106 and contact layer 107 of a conductivity type is carried out to this order through the AlAs layer 104 prepared on this layer, a resonator part is formed, on said contact layer 107, it has opening 113 and the contact electrode 108 is formed. The protective coat 109 is formed so that this whole opening 113 may be covered.
[0066] Furthermore, as it has a contact hole 114 to the field in which the protective coat 109 on said contact electrode 108 is not formed, an insulator layer 110 is formed in it, and it connects with the contact electrode 108 in a contact hole 114, and the wiring electrode 111 is formed on said insulator layer 110. In this invention, although the mode which said contact layer has not exposed is desirable, it is desirable that the contact electrode is formed in the field in which the protective coat or/and insulator layer on a contact layer are not formed.
[0067] moreover, the first voice of this invention -- as the perpendicular resonator mold face luminescence semiconductor laser equipment applied like is shown in drawing 2 , and it is joined to the contact electrode exposed in the contact hole in which both a protective coat 109 and the insulator layer 110 are not formed and laps on a protective coat (front face), the wiring electrode 111 may be arranged.
[0068] It is desirable to make the reflection factor of the light in the laser wavelength of the reflector which comes to contain the second semi-conductor multilayers reflecting mirror 106, contact layer 107, and protective coat 109 of a conductivity type emitted located in the upper layer of a barrier layer 103 into the range used as the abbreviation maximum, i.e., maintainable high thickness, as thickness of said

protective coat. Although said thickness says the distance from the interface in contact with a contact layer to this interface and the front face (an exposure abbreviation front face of the protective coat of a flat field) of the protective coat which counters and is influenced by the thickness of a contact electrode, the reflection factor of the light in a reflector, etc. Specifically, it is the numeric value given by d= (lambda/2) and (N/n) [the thickness (micrometer) of d:protective coat, the wavelength (nm) of lambda:laser beam, the N:1 or more natural numbers, and the refractive index of n:protective coat]. When the thickness of a protective coat separates greatly from the above-mentioned value, the reflection factor of the light in said reflector may fall, and the result which increases a threshold current value may be caused.

[0069] As the quality of the material of said protective coat, the transparent medium which is chosen from SiO2 film, the SiOxNy film, the SiNx film, and the InxSnyOz film (ITO film) and which makes a laser beam penetrate is desirable. As the formation approach of a protective layer, there is especially no limitation and it can be chosen suitably.

[0070] Said contact layer can be formed by approaches, such as metal-organic chemical vapor deposition, with the lower DBR layer (first semi-conductor multilayers reflecting mirror) and barrier layer which make a body part, a spacer layer, and an up DBR layer (second semi-conductor multilayers reflecting mirror), using trimethylgallium (TMG) and an arsine (AsH3). In the case of the short wavelength region VCSEL which has output wavelength in short wavelength regions, such as 780 etc.nm, generally as thickness of this contact layer, it is 0.005-0.05 micrometers.

[0071] As said semi-conductor substrate, you may be any of a conductivity type and a non-conductivity type, and according to the classification of a barrier layer, what consists of ingredients, such as a gallium arsenide and indium phosphide, can be used, choosing it suitably. It is determined almost uniquely by the luminescence wavelength of the laser made into the purpose in fact, for example, as for a GaAs substrate and the case of 1100-1550nm, an InP substrate is chosen when wavelength is 480-980nm.

[0072] Although the lower electrode 112 is formed in one front face of this semi-conductor substrate, this lower electrode 112 bears the function of electric contact at the time of emitting a photon, and said semi-conductor substrate constitutes a part of cable run at this time. That is, the first semi-conductor multilayers reflecting mirror 102 is electrically connected with electric contact through a semi-conductor substrate. Said semi-conductor multilayers reflecting mirror 102 may be connected to the power source in other modes. Generally, after said lower electrode forms a conductive metal by sputtering or vacuum evaporationo, it can be formed by the well-known method of annealing and forming.

[0073] The said first and second semi-conductor multilayers reflecting mirrors 102,106 Two or more intersection alternation of strata is the distributed process input output equipment Bragg reflection mirrors (DBR) by which the laminating was carried out. Each of said intersection alternation of strata It is the ingredient layer which has a different refractive index by turns, and while reflecting the photon generated from the barrier layer 103, raising the optical consistency in a barrier layer and carrying out induction of the laser oscillation, the function which emits a specific wavelength light chosen by the spacer layer from opening of a contact electrode is borne. Said intersection alternation of strata can produce the indium phosphide aluminum gallium (InAlGaP) containing the aluminum and the gallium from which the aluminum gallium arsenide (AlGaAs) containing the aluminum and the gallium from which concentration (namely, content) differs, and concentration (namely, content) differ etc. using the suitable ingredient of arbitration.

[0074] Moreover, the first and second semi-conductor multilayers reflecting mirrors are usually doped by suitable n mold dopant and p mold dopant of arbitration. Generally, it is a selenium (Se), p mold dopants, such as n mold dopants, such as silicon (Si), and carbon (C), zinc (Zn), and beryllium (Be), can be used. Said two or more intersection alternation of strata can also have and constitute the mutual pair of the number of arbitration. That is, for example, in the second semi-conductor multilayers reflecting mirror 102, the first pass and the second layer are made into one mutual pair from a semi-conductor substrate side (the same is said of the first semi-conductor multilayers reflecting mirror 102.), and an arbitration laminating may be carried out and you may consist of gestalten of this mutual pair. Generally, as range of the number of mutual pairs, it is 20-60 pairs, 25-55 pairs are desirable especially,

and the number of nominal ratings is 30-45 pairs.
[0075] Said barrier layer 103 is arranged so that a quantum well layer may be ****(ed) between two-layer barrier layers. Said quantum well layer and a barrier layer are gallium arsenide, Aluminum gallium arsenide, It can manufacture from ingredients, such as an indium phosphide gallium, an indium phosphide aluminum gallium, indium gallium arsenide, and indium phosphide gallium arsenide. They can be doubled with the wavelength of the request which you want to oscillate, and can design and produce the quantum well width of face etc. at arbitration, especially, said quantum well layer and a barrier layer have desirable 50-150A, and its 75-125A is more desirable. Nominal value is 100A.
[0076] As mentioned above, after forming the second semi-conductor multilayers reflecting mirror or contact layer of a conductivity type, Form the contact electrode which has introduction opening, cover electrode opening which serves as the laser beam window by the protective coat immediately by the protective coat, and it sets in a subsequent process. With the perpendicular resonator mold face luminescence semiconductor laser equipment (VCSEL) which advanced and produced the process, without exfoliating said protective coat, since a contact electrode can be certainly formed in the contact layer which consists of thin GaAs first, the property by which whose I-V property of a device is low resistance, and was moreover stabilized is acquired. Moreover, since outgoing radiation opening is not put a laser beam window to the plasma or drug solution in the middle of a process, it is lost that GaAs in the maximum surface section of a contact layer is etched, and AlGaAs etc. is exposed. consequently, the melanism in which a laser beam window oxidizes and carries out melanism when leaving or current pouring in the device which could realize the high increase in power of a laser output, and was moreover produced into atmospheric air -- without causing a phenomenon, it can avoid that a laser output declines with time amount, and the dependability of a device can be raised.
[0077] Next, the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention concerning the second mode is explained. The perpendicular resonator mold face luminescence semiconductor laser equipment of said second mode On the front face of a semi-conductor substrate, at least The first semi-conductor multilayers reflecting mirror, It has a barrier layer, the second semi-conductor multilayers reflecting mirror, and the basic structure that the contact layer deposited on this order if needed, i.e., a perpendicular resonator part. Further A protective coat, It has the structures, such as the contact electrode and insulator layer which are on said second semi-conductor multilayers reflecting mirror or a contact layer, and are prepared so that it may lap on the front face of a protective coat, and have a laser beam window (opening), and a wiring electrode, and is constituted. said contact layer -- said first voice -- when it is not necessary like perpendicular resonator mold face luminescence semiconductor laser equipment [like] to necessarily prepare when the second semi-conductor multilayers reflecting mirror also has the function of a contact layer, and it does not have the function of a contact layer conversely, it is desirable to prepare a contact layer at the point which raises a laser output. In addition, said perpendicular resonator part may be constituted like drawing 8 R> 8 as stated above.
[0078] In this mode, a protective coat is formed as the structure (the first structure) of the ** point in two or more structures finally arranged on the second semi-conductor multilayers reflecting mirror or a contact layer. That is, in order to avoid the damage to a laser beam window (opening) as much as possible at least, a protective coat is formed before which the structure is prepared on the second semi-conductor multilayers reflecting mirror or a contact layer. therefore, the first voice -- not only when it is going to form a contact electrode in a wiring electrode and one, but the effect of the semi-conductor multilayers reflecting mirror or contact layer on the second in the formation process of a contact electrode can be avoided like perpendicular resonator mold face luminescence semiconductor laser equipment [like], and a laser output can be raised more stably. About the concrete manufacture approach, it mentions later.
[0079] In this mode, when a wiring electrode is formed directly in contact with the front face of the second semi-conductor multilayers reflecting mirror or a contact layer, it is not necessary to necessarily prepare a contact electrode apart from said wiring electrode (refer to drawing 24 and 27 grade). If the field in which the protective layer is not prepared is not damaged even if it does not prepare a contact

electrode, it is good, and a wiring electrode can be prepared as it serves as a contact electrode. Thereby, the structure and the manufacture process of equipment can be simplified more. About the concrete manufacture approach, it mentions later.
[0080] What is necessary is for a protective coat to touch the front face of the second semi-conductor multilayers reflecting mirror or a contact electrode, and to just be located as physical relationship with said protective coat, the second semi-conductor multilayers reflecting mirror, or a contact electrode, so that a laser beam window may be covered. For example, it may be prepared in the mode as shown in drawing 17 . Drawing 17 is the block diagram showing an example of the perpendicular resonator mold face luminescence semiconductor laser equipment of the second mode of this invention.
[0081] The perpendicular resonator mold face luminescence semiconductor laser equipment shown by drawing 17 is constituted as follows. That is, a resonator part is formed like said first mode, a protective coat 109 is formed on the contact layer 107, and it laps on the front face of this protective coat 109, and the contact electrode 108 is formed so that opening (laser beam window) 113 may be formed only on a protective layer.
[0082] It connects with the contact electrode 108, said insulator layer 110 is placed between the almost flat field 114 on said contact electrode 108, i.e., a contact hole, and the wiring electrode 111 is formed in it. Although the mode which the contact layer has not exposed is desirable like the perpendicular resonator mold face luminescence semiconductor laser equipment of said first mode, it is desirable that the contact electrode is formed in the field in which the protective coat or/and insulator layer on a contact layer are not formed.
[0083] as the configuration of the front face of said protective layer -- especially -- a limit -- there is nothing -- suitably -- it can choose -- for example, drawing 17 -- like -- abbreviation -- you may come to have an inclination field in the periphery of a flat field and this field. this invention -- setting -- the abbreviation for a protective coat -- the side which contacts a flat field in the condition of having been formed on the semi-conductor multilayers reflecting mirror of the second conductivity type, or the contact layer, with the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer (opposite), and a reverse side -- it is -- the semi-conductor multilayers reflecting mirror of the second conductivity type or a contact layer, and abbreviation -- an parallel front face (exposure) is put.
[0084] although said opening is formed only on a protective layer as stated above -- this opening and abbreviation -- the field which this opening exposes as physical relationship with a flat field and an inclination field -- abbreviation -- the relation in which only a flat field is included -- you may be -- abbreviation -- you may have the relation in which both a flat field and an inclination field are included. It is desirable that the thickness of a protective layer is set as the range in which the reflection factor of light serves as the maximum in a flat field. any case -- said first mode -- the same -- abbreviation -- For example, it sets to the reflector which contains the second semi-conductor multilayers reflecting mirror, contact layer, and protective coat of a conductivity type in the case of the latter as shown in drawing 23 . in the inclination field (taper field) 114, the thickness of a protective coat becomes thick -- alike -- following -- a reflection factor -- large -- becoming -- abbreviation -- a reflection factor is made into max (namely, maximum) in the flat surface field 113. In this case, it can narrow rather than opening which formed the waveguide of the longitudinal direction of laser using the contact electrode substantially, and a desired beam diameter and oscillation mode can also be chosen by controlling the taper angle and configuration of a taper field suitably.
[0085] In addition, about details, such as the lower electrode [of the side which does not have semi-conductor substrates, such as thickness of a protective layer and the quality of the material, the quality of the material of a contact layer, and thickness and a protective coat], first, and second semi-conductor multilayers reflecting mirrors, and a barrier layer, and these desirable modes, it is the same as that of the case of the perpendicular resonator mold face luminescence semiconductor laser equipment of said first mode.
[0086] As mentioned above, after forming the second semi-conductor multilayers reflecting mirror or contact layer of a conductivity type, Form a wrap protective coat for the field used as the introduction

laser beam window, and the contact electrode which has electrode opening as a laser beam window is prepared on this protective layer. With the perpendicular resonator mold face luminescence semiconductor laser equipment (VCSEL) which advanced and produced the subsequent process, without exfoliating said protective coat Since the second semi-conductor multilayers reflecting mirror or contact layer of a conductivity type in a laser beam window can be protected certainly, the property by which whose I-V property of a device is low resistance, and was moreover stabilized is acquired. Moreover, since outgoing radiation opening is not put a laser beam window to the plasma or drug solution in the middle of a process, it is lost that GaAs in the maximum surface section of a contact layer is etched, and AlGaAs etc. is exposed. consequently, the melanism in which a laser beam window oxidizes and carries out melanism when leaving or current pouring in the device which could realize the high increase in power of a laser output, and was moreover produced into atmospheric air -- without causing a phenomenon, it can avoid that a laser output declines with time amount, and the dependability of a device can be raised.

[0087] The perpendicular resonator mold face luminescence semiconductor laser equipment of <manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment> this invention is carried out as the following (the first or the second voice the manufacture approach of perpendicular resonator mold face luminescence semiconductor laser equipment [like]), and can be produced. In the manufacture approach of said first mode, on a semi-conductor substrate, it comes to have the first semi-conductor multilayers reflecting mirror, a barrier layer, the second semi-conductor multilayers reflecting mirror, the contact electrode that has opening, and the process which forms a wrap protective coat in this order for opening completely at least immediately after forming a contact electrode further, and the perpendicular resonator mold face luminescence semiconductor laser equipment of the first mode as stated above is produced.

[0088] In the manufacture approach of said second mode, it comes to have the process which forms the first semi-conductor multilayers reflecting mirror, a barrier layer, the second semi-conductor multilayers reflecting mirror, a protective coat, and the contact electrode that has opening on a semi-conductor substrate at this order, and the perpendicular resonator mold face luminescence semiconductor laser equipment of the second mode as stated above is produced.

[0089] First, on the semi-conductor substrate of a conductivity type, carry out the laminating of two or more intersection alternation of strata from which a refractive index differs, and the semi-conductor multilayers reflecting mirror of the first conductivity type is formed. After carrying out the laminating of the barrier layer which may emit a photon on this reflecting mirror, carrying out the laminating of two or more intersection alternation of strata from which a refractive index differs still like the above and carrying out the laminating of the semi-conductor multilayers reflecting mirror of the second conductivity type, the laminating of the contact layer of a conductivity type is carried out to this if needed, and a perpendicular resonator part is produced.

[0090] This perpendicular resonator part may have the same cross-section structure as a resonator 302 like drawing 8 . The semi-conductor substrate 301 of a conductivity type is prepared. On the front face by the side of [one] this semi-conductor substrate in this case, by metal-organic chemical vapor deposition The lower reflective mirror (the first reflecting mirror) 304 and the spacer layer 306 to which the laminating of two or more intersection alternation of strata from which a refractive index differs was carried out are minded. The up reflective mirror (the second reflecting mirror) 305 which carried out the laminating of two or more intersection alternation of strata from which a refractive index differs through a barrier layer 303 and the AlAs layer 312, and the contact layer 307 carry out a laminating to order, and are prepared in it.

[0091] then, the contact electrode which has (i) opening in the manufacture approach of the first perpendicular resonator mold face luminescence semiconductor laser equipment on said second semi-conductor multilayers reflecting mirror or a contact layer -- or the sacrifice layer which prevents damage on the contact layer at the time of (ii) resist development before formation of a contact electrode is formed. However, also in any of the above (i) and (ii), a contact electrode is formed as the lowest layer on a contact layer, it joins to this contact electrode and the wiring electrode connected with a contact

electrode is formed, after a contact electrode is formed.
[0092] on the other hand -- the manufacture approach of the second perpendicular resonator mold face luminescence semiconductor laser equipment -- setting -- a semi-conductor multilayers reflecting mirror [of said second conductivity type], or contact layer top -- a protective coat (iii) -- or the laminating section by which the laminating of the covering film (etching mask) which can be etched was alternatively carried out to this order to the protective coat formative layer and the protective coat which form the (iv) protective coat is formed. the protective coat formative layer for forming a protective coat also in any of the above (iii) and (iv) before configuration processing of the semi-conductor multilayers reflecting mirror of the second conductivity type, and formation of a contact electrode -- ** -- it is formed previously. in addition, a protection stratification layer -- being the so-called -- a protective coat -- the layer in the condition that patterning is not carried out even to a desired configuration is said.
[0093] After forming a contact layer in the above (i), on this layer, it has opening, a contact electrode is formed, opening is completely covered by the protective coat at least immediately after that, and damage on the contact layer in a subsequent process is avoided. After having an outcrop (contact hole) to the field in which it is on a contact electrode and the protective coat is not formed that insulation with a contact layer, a semi-conductor multilayers reflecting mirror, etc. should be secured after forming a protective coat and forming an insulator layer in it, a wiring electrode is formed on said insulator layer so that it may join to said contact electrode in this contact hole. In this case, it is carried out at processes after the protection stratification, such as formation of an insulator layer, a wiring electrode, etc., without removing said protective coat completely.
[0094] It carries out film deposition on the contact layer, using as a sacrifice layer the film which consists of SiON film etc. beforehand, a resist is applied on this sacrifice layer, photolithography is performed, and patterning of the resist is carried out so that the contact layer which the developer for resist development becomes from GaAs may be contacted in the above (ii) and this GaAs itself may not be etched.
[0095] If it does in this way, a process can be advanced without contacting a developer to GaAs used as the lower layer of a sacrifice layer directly. Moreover, since after pattern NINGU termination of a resist carries out etching removal of the sacrifice layer exposed to opening of said resist pattern and exposes a contact layer, it carries out film deposition of the metallic material used as a contact electrode from said resist. Then, lift off of said metallic material by which film deposition was carried out to the resist on it is carried out, and pattern NINGU of a contact electrode is carried out. The sacrifice layer which remained on the contact layer may be removed, and when convenient, you may make it remain as it is.
[0096] In this invention, although reliable perpendicular resonator mold face luminescence semiconductor laser equipment is producible with both the above (i) and (ii) The approach of preventing the damage which the contact layer by the developer at the time of resist development receives, forming the sacrifice layer beforehand before the approach of the above (ii), i.e., formation of a contact electrode, from a viewpoint which stabilizes a laser output more, and forming a contact electrode after that is more more desirable.
[0097] The laser beam which could avoid thickness change of the contact layer accompanying the damage on pervasion of the contact layer of a field, disappearance, etc. which is going to form a contact electrode like drawing 28 , low resistance-ization without variation was realized, passed by high power by impression of a low battery, and was stabilized in the output without loss of power in the time in the process which forms a contact electrode can be made to discover from the above.
[0098] After carrying out patterning and forming a contact electrode by the approach of the above (ii) Opening is first covered completely by the protective coat at least like the case of the above (i). The contact layer in opening is protected, and after having an outcrop (contact hole) to the field in which the protective coat on a contact electrode is not formed and forming an insulator layer in it, a wiring electrode is formed on said insulator layer so that it may join to a contact electrode in this contact hole.
[0099] As a sacrifice layer formed in the above (ii), the SiON film, the SiNx film, SiO2 film, the InxSnyOz film, the SOG film, etc. are mentioned suitably. Said InxSnyOz film is alternatively desirable to the contact layer which consists of GaAs using dilute hydrochloric acid at the point which can be

etched. Although said sacrifice layer can be suitably formed by the physical well-known film deposition approaches, such as the sputtering method and a CVD method, it is the point that deterioration of the contact layer which consists of GaAs is avoidable, and especially its sputtering method is desirable.

[0100] When using the SOG film as a sacrifice layer, cure, i.e., in order to harden, film formation of this film can be more simply carried out by carrying out annealing treatment below 250 degrees C. That is, if the SOG film is used, since it can form only by being able to apply and carrying out annealing treatment at 300-400 degrees C, even the plasma damage which goes into a contact layer slightly by the sputtering method at the time of film deposition can be avoided, and it is more desirable at a point. And as curing temperature of SOG, a cure is possible at low temperature 250 degrees C or less, it is the point which can control oxidation of a contact layer front face, and the effectiveness which can form contact resistance into low resistance more can also be expected.

[0101] As thickness of said sacrifice layer, 0.05-0.3 micrometers is desirable. When pinholes may increase in number and the engine performance as a sacrifice layer may be remarkably spoiled, when said thickness is less than 0.05 micrometers, and it exceeds 0.3 micrometers, side etching of the sacrifice layer in a next process may induce the failure by the entering resist greatly. Furthermore, when the case where a sacrifice layer is left is taken into consideration, it is desirable that it is the thickness by which said thickness is in the above-mentioned range, and the total reflection factor of a semi-conductor multilayers reflecting mirror and a sacrifice layer is maintained highly.

[0102] As mentioned above, after forming a sacrifice layer beforehand, by forming a contact electrode, the contact layer which consists of GaAs does not contact a resist developer, etching and disappearance of a contact layer can be prevented, and the AlGaAs layer which is moreover in the lower layer is not exposed to a front face. Therefore, since an electrode can be certainly formed on the contact layer which has the thickness set up in early stages,-izing of the I-V property of the produced device can be carried out [low ****], and the stable property with little variation is acquired. Moreover, since the front face of the contact layer in a laser beam window (GaAs layer) is not etched, either, the process resistance in this front face can improve, and can suppress deterioration in the process in a laser beam window as much as possible. Consequently, deterioration of outgoing radiation opening at the time of leaving or current pouring in into atmospheric air is suppressed as much as possible, and the initial laser output characteristics of a device not only improve, but it can control degradation by the passage of time of a laser output to the minimum. In addition, it is possible by combining a wrap protective coat for said sacrifice layer and outgoing radiation opening (opening) about outgoing radiation opening to heighten the effectiveness more.

[0103] In the above (iii), as it has opening which forms and etches the protective coat formative layer, arranges a protective coat, avoids damage on the semi-conductor multilayers reflecting mirror of the second conductivity type in a subsequent process, or a contact layer, and touches on the front face of this protective coat further, and a protective coat exposes only on this front face, a contact electrode is formed on the semi-conductor multilayers reflecting mirror of the second conductivity type, or a contact layer. After having an outcrop (contact hole) to the field in which it is on a contact electrode and the protective coat is not formed that insulation with a contact layer, a semi-conductor multilayers reflecting mirror, etc. should be secured and forming an insulator layer in it, a wiring electrode is formed on said insulator layer so that it may join to said contact electrode in this contact hole. In this case, it is carried out at processes after the protection stratification, such as formation of an insulator layer, a wiring electrode, etc., without removing said protective coat completely.

[0104] In the above (iv), the laminating section with the covering film (etching mask) which can be etched is alternatively formed to the protective coat formative layer and the protective coat for forming a protective coat sequentially from the semi-conductor multilayers reflecting mirror side of the second conductivity type, or a contact layer side, and it etches into the pattern of the shape of a mask of ** which processes poststructure. By using this laminating section as a mask, postprocessing is carried out, after covering the whole post with the insulator layer from which the protective coat formative layer and etch selectivity differ, a resist is formed further, an insulator layer and the covering film are etched by using this resist as a mask, and the beer for contact hole formation is formed. A resist is further formed

in this, it considers as a mask and the contact hole which etches the protective coat formative layer and a protective coat, the second semi-conductor multilayers reflecting mirror, and a contact layer expose is formed. Then, the second semi-conductor multilayers reflecting mirror to expose or a contact layer is made to contact, and a wiring electrode is formed. Immediately after exposing, after the second semi-conductor multilayers reflecting mirror and contact layer are exposed, before an outcrop receives damage in a process, a wiring electrode is formed. In this case, a wiring electrode is formed to serve also as a contact electrode, and does not necessarily need to form a contact electrode separately.
[0105] The thickness change accompanying damage on the second semi-conductor multilayers reflecting mirror of the field which is going to form the contact electrode in the process which forms a contact electrode like [above] the above (ii) as shown in drawing 28 , or a contact layer can avoid, and the laser beam which low resistance-ization without variation was realized, passed by high power by impression of a low battery, and was stabilized in an output without loss of power in the time can make discover.
[0106] In the process after the protective coat formation in the above (i) - (iv), it is desirable to use alternatively the ingredient with which the ingredient which constitutes the ingredient which can be etched, i.e., a protective layer, to a protective coat differs from an etch rate as film prepared as the covering film which covers a second semi-conductor multilayers reflecting mirror [which has a protective coat], or contact layer top, i.e., an etching mask, an insulator layer, etc. for etching. Specifically, SiO2, SiOxNy, SiNx, InxSnyOz, etc. are mentioned.
[0107] It is desirable that either a protective coat and the covering film are constituted by SiO2, SiOxNy, and SiNx, and another side is constituted by InxSnyOz especially. Especially the thing come to constitute a protective coat SiO2, SiOxNy, or SiNx, and it comes to consist of enveloping layers InxSnyOz especially is desirable.
[0108]
[Example] Although the example of this invention is explained below, this invention is not limited to these examples at all.
(Example 1) As it was the following, the perpendicular resonator mold face luminescence semiconductor laser equipment (the first mode of this invention) which has the same structure as drawing 1 was produced.
[0109] On the Si dope (Nd=1x1018cm-3) n mold GaAs semi-conductor substrate 101 The Si dope (Nd=1x1018cm-3) n mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror 102 of 40.5 periods (DBR layer), The undoping lambdaaluminum0.6Ga0.4As spacer layer 105 and the 3-fold quantum-well aluminum0.11Ga0.89 As/aluminum0.3Ga0.7As barrier layer 103, The Zn dope (Na=7x1017cm-3) p mold AlAs layer 104, Zn dope (Na=7x1017cm-3) p mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As of 30.5 periods DBR layer 106, Laminating formation of the Zn dope (Na=1x1019cm-3) p mold GaAs layer (contact layer) 107 was carried out at this order (an Si dope n mold GaAs buffer layer is un-illustrating). Said Zn dope (Na=7x1017cm-3) p mold AlAs layer 104 consists of oxidation field 104A and non-oxidizing field 104B.
[0110] Furthermore, the contact electrode 108 which has opening 113 directly in contact with this layer is formed on the GaAs contact layer 107, and said opening 113 is completely covered by the SiON protective coat 109. The path of said protective coat 109 has a larger path than the path of the opening 113 of said contact electrode 108, and is formed.
[0111] Moreover, it has a contact hole 114, on said contact electrode 108, as an interlayer insulation film 110 covers poststructure, it is formed, and on this interlayer insulation film, the wiring electrode 111 is formed in contact with said contact electrode 108. Here, when it has the field with which said contact electrode 108 and interlayer insulation film 110 lap like drawing 1 , said contact electrode 108 is arranged rather than said interlayer insulation film 110 at a lower layer. The wiring electrode 111 has touched on the front face of the contact electrode 108 in the field 114 of a protective coat 109 and an interlayer insulation film 110 which went out, i.e., a contact hole. That is, the contact electrode is located in the lowest layer in the structure formed on the contact layer. The mode with which the front face of the contact layer 107 of the field is covered with the contact electrode 108 and which the contact layer

has not exposed is desirable in said contact hole 114.
[0112] Below, the example is explained using drawing 3 -5 about the concrete production approach of the AlAs oxidation type VCSEL concerning the first mode of this invention.
(1) the bulk crystal of groups III-V semiconducter, such as production **** of a VCSEL thin film substrate (semi-conductor substrate), and GaAs, -- a substrate -- carrying out -- organic metal gaseous layer growth (Metal Organic Vapor Phase Epitaxy:MOVPE) -- by law, sequential epitaxial growth of the III-V group compound (GaAs, AlGaAs) semi-conductor thin film was carried out, two or more layer laminating formation was carried out, and the semi-conductor multilayers reflecting mirror 203 of the first conductivity type was formed. On this semi-conductor multilayers reflecting mirror 203, it has a barrier layer, a spacer layer, the semi-conductor multilayers DBR reflecting mirror of the second conductivity type, and a contact layer at least as mentioned above. Hereafter, this substrate is called a "VCSEL thin film substrate." Specifically, it is as follows.
[0113] Namely, on the Si dope (Nd=1x1018cm-3) n mold GaAs semi-conductor substrate 201 the Si dope (Nd=1x1018cm-3) n mold GaAs buffer layer 202, the Si dope (Nd=1x1018cm-3) n mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror (DBR layer) 203 of 40.5 periods, and undoping lambda Zn dope of the 208 or 3-fold aluminum0.6Ga0.4As spacer layer quantum well aluminum0.11Ga0.89 As/aluminum0.3Ga0.7As barrier layer 204, the Zn dope (Na=7x1017cm-3) p mold AlAs layer 205, and 30.5 periods (Na=7x1017cm-3) Sequential membrane formation of each class of the p mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1AsDBR layer 206 and the Zn dope (Na=1x1019cm-3) p mold GaAs layer 207 was carried out.
[0114] In order to lower the series resistance of a device, the band obstruction buffer coat of the presentation between aluminum0.3Ga0.7As and aluminum0.9Ga0.1As may be inserted in the class interface of said p type of aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror (DBR layer).
[0115] (2) production of p contact electrode which has opening, next drawing 3 - it is shown in (2) -- as -- said MOVPE -- p contact electrode 209 which has the opening 210 for laser outgoing radiation on the front face of the contact layer 207 which is the outermost layer of the VCSEL thin film substrate produced by law was produced by the following approach. the lift-off method which exfoliates and carries out electrode formation of said resist after this p contact electrode forms a resist pattern in the front face of the contact layer 207 which is the outermost layer with the usual photolithography and carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, a resist pattern is formed with the usual photolithography on this Au film, and it can produce suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. can also be used as an ingredient of said p contact electrode.
[0116] (3) Formation drawing 3 of the protective coat formative layer - As shown in (3), after producing said contact electrode 209, film deposition of the insulator layer which consists of SiON, SiNx, and SiO2 film with a CVD system, a sputtering system, etc. was carried out all over the front face of a near VCSEL thin film substrate in which the contact electrode 209 was formed, and the protective coat formative layer 211 was formed. In order to use the thickness of a protective coat also as a mask of next postetching, it needs to form membranes more thickly than a part for the thickness which disappears by etching.
[0117] (4) n rear-face electrode film deposition -- here -- drawing 3 - as shown in (4), film deposition of the n electrode 212 was carried out to the front face of a near VCSEL thin film substrate in which the contact electrode 209 is not formed with vacuum evaporationo equipment. AuGe/Au and AuGe/nickel/Au are mentioned as an ingredient of these n electrodes. Moreover, in order to use said two electrodes as a low resistance ohmic electrode at this time, it annealed for several minutes to 30 minutes under the 350-400-degree C nitrogen-gas-atmosphere mind of temperature.
[0118] (5) Delete the both ends of the formation VCSEL thin film substrate of the mask for postetching, and it is drawing 4 . - It is drawing 4 about said protective coat formative layer 211 which carried out film deposition at the process of the above (3) in order to consider as the poststructure of the shape of a column as shown in (6). - Patterning was carried out to the configuration as shown in (5), and it

considered as the etching mask 213 as it is. Resist spreading, photolithography, and etching performed patterning. Fluoric acid system etchant, dry etching, etc. can perform etching.
[0119] (6) number - to which even the edge of the AlAs layer 205 exposes formation of poststructure, next parts other than said etching mask 213 with the dry etching system using chlorine-based gas -- Fukashi who is about ten micrometers -- dry etching -- carrying out -- drawing 4 - the poststructure 214 as shown in (6) was formed. At this time, the cross section of the cascade screen of a VCSEL thin film substrate is exposed to a postside face.
[0120] (7) After producing AlAs oxidation process post structure, it inserted into the annealing furnace immediately, the steam was introduced, and selective oxidation of an AlAs layer was performed from the postside face (refer to drawing 4 -(7)). Annealing temperature at that time was made into about 350-400 degrees C. Moreover, said steam was introduced by carrying out bubbling of the 70-100-degree C hot water in a hot water tank with nitrogen carrier gas, and conveying it in a furnace. Although high AlGaAs and the AlAs layer of aluminum presentation change to an aluminum oxide (AlxOy) by performing steam oxidation, the oxidation by which only an AlAs layer goes [the direction of an AlAs layer] to a postcore from a postside-attachment-wall edge alternatively since the oxidation rate is overwhelmingly quick compared with AlGaAs advances, and an oxidizing zone 215 is formed. Here, only request size can leave the AlAs layer 205 to a postcenter section by controlling annealing time amount. Said AlxOy layer 215 has small electrical conductivity to the degree of pole, and since the AlAs layer 205 has large electrical conductivity, it can make it the structure where a current flows only in the AlAs layer 205 left behind to the core of poststructure.
[0121] (8) Drawing 4 after performing AlAs oxidation at the process of the film deposition above (7) of an interlayer insulation film - As shown in (8), the whole post was completely covered with the interlayer insulation film 216 which consists of SiON. This is for preventing deterioration of the oxidizing zone by the porous AlxOy film being placed in the condition of having exposed to the edge of a postside attachment wall in order to reinforce the fall of the post [itself] produced by having permuted most AlAs layers by the porous AlxOy film on the strength.
[0122] (9) At the etching back following **, it is drawing 5 . - As shown in (9), the etching back of some said interlayer insulation films 216 and etching masks 213 (217A) was performed, and thickness 217B of the etching mask 213 was made into the thickness by which the reflection factor of the reflector constituted including the semi-conductor multilayers reflecting mirror 206 and the contact layer 207 which exist in a lower layer, and a protective coat 213 is maintained highly (etching back process). When it is not necessary to have desired thickness beforehand or and a reflection factor does not need to be raised so much, the above-mentioned etching back process may be skipped.
[0123] (10) The contact hole 218 for making the contact electrode which is the lower layer of the protective coat and interlayer insulation film in the poststructure upper part ground p wiring electrode was opened by carrying out patterning and etching with production and also photolithography of a contact hole. Etching by drug solutions, such as buffered fluoric acid (BHF), and dry etching can perform etching. If it is the mode in which the contact electrode 209 was formed all over the pars basilaris ossis occipitalis of a contact hole 218 at this time, the damage to the contact layer 207 of further a lower layer received in the middle of a process is avoidable with a contact electrode.
[0124] (11) On an interlayer insulation film 216, connect with a contact electrode, form p wiring electrode 219 at the formation last of p wiring electrode, and it is drawing 5 . - The perpendicular resonator mold face luminescence semiconductor laser equipment of this invention which has the cross-section structure shown in (11) was produced. the lift-off method which said p wiring electrode 219 forms a resist pattern with the usual photolithography, and exfoliates and forms a resist after carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, and a resist pattern is formed with the usual photolithography on Au film, and it can form suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. may be used for p electrode material.
[0125] As mentioned above, contact resistance was low, and the field luminescence semiconductor laser equipment of a reliable perpendicular resonator mold was able to be produced, without having obtained

the laser beam of high power and moreover a laser output declining with time amount by impressing a low battery.
[0126] (Example 2) After performing the process shown in drawing 3 - (1) of 4 - (8) as well as an example 1, as an approach of forming a contact hole in the poststructure upper part of a VCSEL thin film substrate The process (drawing 5 -(9) - (10)) of (9) and (10) performed in the example 1 is shown below (10-a), It replaced with the process (refer to drawing 6), and and (10-b) produced the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention. (9-a)
[0127] Below, the concrete production approach is explained using drawing 6 .
(9-a) The resist 502 was formed on the etching drawing 4 -this interlayer insulation film 216 of the insulator layer center section of the poststructure upper part as shown in (8), after covering the whole post with the interlayer insulation film 216 which consists of SiON completely, and patterning of the resist 502 was carried out to the configuration shown in drawing 6 - (9-a) with photolithography. Only the center section 503 of the interlayer insulation film of the poststructure upper part was etched by using this resist 502 as a mask using buffered fluoric acid. Dry etching can also perform this etching. The thickness 501 of the protective coat on opening of a contact electrode suspended etching in the depth used as predetermined thickness at that time, without etching until a contact electrode is completely exposed. It is desirable to consider as the thickness by which the reflection factor of the reflector of a VCSEL thin film substrate is maintained relatively highly as predetermined thickness. The resist 502 was removed after the above-mentioned etching.
[0128] (10-a) As shown in the resist formation for contact hole formation, next drawing 6 - (10-a), the resist 504 was formed with photolithography on the protective coat of the opening right above of a contact electrode, as other fields were etched by making this into a mask and it was shown in drawing 6 - (10-b), the interlayer insulation film and the protective coat were removed, and etching was suspended in the place which the contact hole 505 opened. At this time, the interlayer insulation film 506 on a protective coat was etched, and thickness became small rather than the original thickness. As shown in drawing 6 - (10-b), after the contact hole 505 was formed, p wiring electrode was formed like the process of (11) of an example 1.
[0129] As mentioned above, like the example 1, when contact resistance impressed a low battery low, the laser beam of high power was obtained and the field luminescence semiconductor laser equipment of the reliable perpendicular resonator mold with which a laser output moreover does not decline with time amount was able to be produced.
[0130] (Example 3) After performing the process shown in drawing 3 - (1) of 5 - (9) as well as an example 1, as an approach of forming a contact hole in the poststructure upper part of a VCSEL thin film substrate In the process of (9) and (10) performed in the example 1, two or more small contact holes 114 as shown in drawing 7 were formed, and the protective coat 109 was formed so that the whole upper part of the poststructure instead of a circular island configuration like drawing 1 might be covered. It comes to carry out two or more arrangement of not the annular contact hole configuration surrounding a protective coat as showed the configuration of said contact hole 114 by drawing 1 but the small contact hoe. As mentioned above, it is related with the configuration of a protective coat and a contact hole, and the variation of shoes can be considered, and there is especially no limit and it may consist of which modes. drawing 7 -- as an example of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention -- the top face and A-A' -- it is drawing showing the cross section of a between.
[0131] Like the example 1, when contact resistance impressed a low battery low, the laser beam of high power was obtained and the field luminescence semiconductor laser equipment of the reliable perpendicular resonator mold with which a laser output moreover does not decline with time amount was able to be produced.
[0132] In an example 1, about the protective coat and etching mask which were formed using the film of the same kind, (Example 4) In this example The protective coat formed after contact electrode formation is formed with the SiON film. Carry out patterning of the account protective coat of direct back to front, and the last configuration of a protective coat is produced beforehand. Form a postetching mask and an

interlayer insulation film with different SiNx film from said protective coat on said protective coat by which patterning was carried out, and it leaves the protective coat by which patterning was already carried out. As only an interlayer insulation film and a postetching mask are alternatively removed by dry etching, they form a contact hole. Below, the concrete production approach is explained using drawing 9 -12.

[0133] (1) the bulk crystal of groups III-V semiconducter, such as production **** of a VCSEL thin film substrate (semi-conductor substrate), and GaAs, -- a substrate -- carrying out -- organic metal gaseous layer growth (Metal Organic Vapor Phase Epitaxy:MOVPE) -- by law, sequential epitaxial growth of the III-V group compound (GaAs, AlGaAs) semi-conductor thin film was carried out, two or more layer laminating formation was carried out, and the semi-conductor multilayers reflecting mirror 603 of the first conductivity type was formed. On this semi-conductor multilayers reflecting mirror 603, it has a barrier layer, a spacer layer, the semi-conductor multilayers DBR reflecting mirror of the second conductivity type, and a contact layer at least as mentioned above. Hereafter, this substrate is called a "VCSEL thin film substrate." Specifically, it is as follows.

[0134] Namely, on the Si dope (Nd=1x1018cm-3) n mold GaAs semi-conductor substrate 601 the Si dope (Nd=1x1018cm-3) n mold GaAs buffer layer 602, the Si dope (Nd=1x1018cm-3) n mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror (DBR layer) 603 of 40.5 periods, and undoping lambda Zn dope of the 608 or 3-fold aluminum0.6Ga0.4As spacer layer quantum well aluminum0.11Ga0.89 As/aluminum0.3Ga0.7As barrier layer 604, the Zn dope (Na=7x1017cm-3) p mold AlAs layer 605, and 30.5 periods (Na=7x1017cm-3) Sequential membrane formation of each class of the p mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1AsDBR layer 606 and the Zn dope (Na=1x1019cm-3) p mold GaAs layer 607 was carried out.

[0135] In order to lower the series resistance of a device, the band obstruction buffer coat of the presentation between aluminum0.3Ga0.7As and aluminum0.9Ga0.1As may be inserted in the class interface of said p type of aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror (DBR layer).

[0136] (2) production of p contact electrode which has opening, next drawing 9 - it is shown in (2) -- as -- said MOVPE -- p contact electrode 609 which has the opening 610 for laser outgoing radiation on the front face of the contact layer 607 which is the outermost layer of the VCSEL thin film substrate produced by law was produced by the following approach. the lift-off method which exfoliates and carries out electrode formation of said resist after this p contact electrode forms a resist pattern in the front face of the contact layer 607 which is the outermost layer with the usual photolithography and carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, a resist pattern is formed with the usual photolithography on this Au film, and it can produce suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. can also be used as an ingredient of said p contact electrode. (3) Production drawing 9 of a protective coat - As shown in (3), after producing said contact electrode 609, with the CVD system, the sputtering system, etc., film deposition of the SiON film was carried out all over the front face of a near VCSEL thin film substrate in which the contact electrode 609 was formed, and the protective coat formative layer 611 was formed. In order to use the thickness of a protective coat 611 also as a mask of next postetching, it needs to form membranes more thickly than a part for the thickness which disappears by etching.

[0137] (4) the patterning aforementioned protective coat 611 top of a protective coat -- a resist -- forming -- fluorine system dry etching -- or the wet etching by buffered fluoric acid -- drawing 9 - as shown in (4), protective coat 611B which makes the last gestalt of a device at this time was formed by carrying out patterning of the protective coat.

[0138] (5) n rear-face electrode film deposition -- here -- drawing 10 - as shown in (5), film deposition of the n electrode 612 was carried out to the front face of a near VCSEL thin film substrate in which protective coat 611B is not prepared with vacuum evaporationo equipment. Then, annealing treatment was performed to the two electrodes of p and n for several minutes - 30 minutes under the 350-400-degree C nitrogen-gas-atmosphere mind of temperature, and it considered as the ohmic electrode.

[0139] (6) It is drawing 10 in order to consider as the poststructure of the shape of the film deposition of the mask material for postetching, and a patterning column of the mask by etching. - As shown in (6), film deposition of the SiNx film 613 was carried out as a dry etching mask with the CVD method all over the front face of a near VCSEL thin film substrate in which protective coat 611B etc. was prepared. Then, the resist was further formed on said SiNx film 613, the SiNx film 613 was etched by having used this resist as the mask, and postetching mask 613B was formed (drawing 10 - (7)).
[0140] (7) number - to which even the edge of the AlAs layer 605 exposes formation of poststructure, next parts other than said etching mask 613B with the dry etching system using chlorine-based gas -- Fukashi who is about ten micrometers -- dry etching -- carrying out -- drawing 11 - the poststructure 614 as shown in (8) was formed. At this time, the cross section of the cascade screen of a VCSEL thin film substrate is exposed to a postside face.
[0141] (8) After producing AlAs oxidation process post structure, it inserted into the annealing furnace immediately, the steam was introduced, and selective oxidation of an AlAs layer was performed from the postside face (refer to drawing 11 -(9)). Annealing temperature at that time was made into about 350-400 degrees C. Moreover, said steam was introduced by carrying out bubbling of the 70-100-degree C hot water in a hot water tank with nitrogen carrier gas, and conveying it in a furnace. Although high AlGaAs and the AlAs layer of aluminum presentation change to an aluminum oxide (AlxOy) by performing steam oxidation, the oxidation by which only an AlAs layer goes [the direction of an AlAs layer] to a postcore from a postside-attachment-wall edge alternatively since the oxidation rate is overwhelmingly quick compared with AlGaAs advances, and an oxidizing zone 615 is formed. Here, only request size can leave the AlAs layer 605 to a postcenter section by controlling annealing time amount. Said AlxOy layer 615 has small electrical conductivity to the degree of pole, and since the AlAs layer 605 has large electrical conductivity, it can make it the structure where a current flows only in the AlAs layer 605 left behind to the core of poststructure.
[0142] (9) Drawing 11 after performing AlAs oxidation at the process of the film deposition above (8) of an interlayer insulation film - As shown in (8), the whole post was completely covered with the interlayer insulation film 616 which consists of SiNx.
[0143] (10) It is drawing 12 in order to open a contact hole in formation and its etching interlayer insulation film 616 of the resist for contact hole formation, and the residual membrane 613 of a postetching mask. - As shown in (11), the resist 617 was further formed on the interlayer insulation film. Then, if it etches by the mixture of gas of 6 sulfur fluorides (SF6) and oxygen (O2) Since the etch rate of protective coat 611B which consists of SiON film is smaller than the etch rate of the postetching mask 613B and the interlayer insulation film 616 which are located in the upper layer and which consist of SiNx, It remains without being etched, only said postetching mask 613B and interlayer insulation film 616 are etched alternatively, and said protective coat 611 is drawing 12 . - The contact hole 618 was formed in the perimeter of patternized protective coat 611B as shown in (12).
[0144] (11) the resist 617 used for formation of a contact hole at the process of the exfoliation above (10) of a resist -- organic washing -- or ashing removed (drawing 12 - (13)).
[0145] (12) On an interlayer insulation film 616, connect with a contact electrode, form p wiring electrode 619 at the formation last of p wiring electrode, and it is drawing 12 . - The perpendicular resonator mold face luminescence semiconductor laser equipment of this invention which has the cross-section structure shown in (14) was produced. the lift-off method which said p wiring electrode 619 forms a resist pattern with the usual photolithography, and exfoliates and forms a resist after carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, and a resist pattern is formed with the usual photolithography on Au film, and it can form suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. may be used for p electrode material.
[0146] As mentioned above, contact resistance was low, and the field luminescence semiconductor laser equipment of a reliable perpendicular resonator mold was able to be produced, without having obtained the laser beam of high power and moreover a laser output declining with time amount by impressing a low battery.

[0147] (Example 5) This example is produced in front rather than it forms which the structure of others excluding a sacrifice layer in a contact electrode in the phase in early stages of a process, i.e., a contact layer top. According to the sequence shown below, the perpendicular resonator mold face luminescence semiconductor laser equipment (AlAs oxidation type VCSEL) which has the same structure as drawing 1 was produced. the following and AlAs oxidation type VCSEL -- the example is explained, using drawing 13 -16 as the concrete production approach.
[0148] (1) the bulk crystal of groups III-V semiconducter, such as production **** of a VCSEL thin film substrate (semi-conductor substrate), and GaAs, -- a substrate -- carrying out -- organic metal gaseous layer growth (Metal Organic Vapor Phase Epitaxy:MOVPE) -- by law, sequential epitaxial growth of the III-V group compound (GaAs, AlGaAs) semi-conductor thin film was carried out, two or more layer laminating formation was carried out, and the semi-conductor multilayers reflecting mirror 103 of the first conductivity type was formed. On this semi-conductor multilayers reflecting mirror 703, it has a barrier layer, a spacer layer, the semi-conductor multilayers DBR reflecting mirror of the second conductivity type, and a contact layer at least as mentioned above. Hereafter, this substrate is called a "VCSEL thin film substrate." Specifically, it is as follows.
[0149] Namely, drawing 13 - As shown in (1), on the Si dope (Nd=1x1018cm-3) n mold GaAs semi-conductor substrate 701 the Si dope (Nd=1x1018cm-3) n mold GaAs buffer layer 702, the Si dope (Nd=1x1018cm-3) n mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror (DBR layer) 703 of 40.5 periods, and undoping lambda Zn dope of the 708 or 3-fold aluminum0.6Ga0.4As spacer layer quantum well aluminum0.11Ga0.89 As/aluminum0.3Ga0.7As barrier layer 704, the Zn dope (Na=7x1017cm-3) p mold AlAs layer 705, and 30.5 periods (Na=7x1017cm-3) Sequential membrane formation of each class of the p mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1AsDBR layer 706 and the Zn dope (Na=1x1019cm-3) p mold GaAs layer 707 was carried out.
[0150] In order to lower the series resistance of a device, the band obstruction buffer coat of the presentation between aluminum0.3Ga0.7As and aluminum0.9Ga0.1As may be inserted in the class interface of said p type of aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror (DBR layer).
[0151] (2) On film deposition - of the production-** sacrifice layer of p contact electrode which has opening, next the drawing 13 -contact layer 707 on the VCSEL thin film substrate obtained as shown in (2), film deposition of the SiON was carried out with the sputtering system, and the sacrifice layer 709 of 0.1 micrometers of thickness was formed. At this time, SiON was set as the thickness which the contact layer 707 which blocks a developer completely at a next FOTORISO process, and consists of GaAs is not made to touch.
[0152]
- Formation -, next drawing 13 of the resist for ** contact electrode lift off - As shown in (3), the resist for contact electrode lift off was formed in the following procedures on the SiON film of said sacrifice layer. That is, after prebaking by applying a coating liquid-like resist all over the SiON film top of said sacrifice layer, it exposed with the negative pattern of a contact electrode (patterning), this was developed with the resist developer, and opening 711 was formed. Since there was a sacrifice layer which consists of SiON in a resist lower layer at this time, the contact layer which consists of GaAs was not able to touch a direct developer, therefore etching by the developer of this contact layer was able to be avoided effectively.
[0153]
- Etching of the sacrifice layer in ** same resist pattern - In this phase, it is drawing 13 . - As shown in (3), the SiON film of the sacrifice layer 709 of the field of the opening 711 of the resist by which patterning was carried out is in the situation which covered the contact layer 707. Therefore, even if it carries out film deposition of the electrode metal with this condition, only by film deposition being carried out on a sacrifice layer, a contact layer and an electrode metal will not have contact, but a current will be poured into a device. Then, while it had been in the condition that said resist pattern 710 was formed, using buffered fluoric acid, the sacrifice layer 709 (SiON film) of the field of opening 711 was

etched completely, and the lower layer contact layer (GaAs layer) 707 was exposed. For a certain reason, the etching resistance of the GaAs layer to buffered fluoric acid cannot fully delete a GaAs contact layer by this etching in this phase.

[0154]

- It is drawing 14 by the film deposition (formation of contact electrode)-resistance heating vacuum evaporationo machine of ** electrode metal, the electron-beam-evaporation machine, or the spatter. - As shown in (5), film deposition of Ti and the Au was carried out one by one, and the electrode metal 712 (contact electrode) was formed.

[0155]

- The resist 710 was exfoliated with the electrode metal 712 using organic washing or resist exfoliation liquid after the lift off of ** resist, and formation of the removal-electrode metal 712 of a sacrifice layer. At the end, fluoric acid removes the sacrifice layer 709 which remains whenever [buffer], and it is drawing 15 . - As shown in (7), only the contact electrode 712 which has opening was formed on the contact layer.

[0156] Although the above is the formation approach of the contact electrode using a sacrifice layer, about the above-mentioned sacrifice layer, it is not restricted to the SiON film but can be adapted also for the insulator layer which carried out film deposition by the spatter, SiO2, SiNx, or the insulator layer that carried out film deposition by CVD. The effect which the direction of the spatter film has on the lower layer GaAs contact layer by the spatter film and the CVD film is desirable at few points. Moreover, said sacrifice layer may be the film which carried out the spin coat, carried out the cure of the SOG and hardened it. Since oxidation of a contact layer front face can be reduced as the curing temperature of SOG is 250 degrees C or less, what has contact resistance good at low resistance is obtained. Furthermore, even if a sacrifice layer is not an insulator layer, it may be InxSnyOz which is a transparent electrode ingredient, and the solution of hydrochloric acid is suitable for it as etchant which removes said sacrifice layer.

[0157] (3) At the n rear-face electrode film deposition following **, it is drawing 15 . - As shown in (8), film deposition of the n electrode 713 was carried out to the front face of a near VCSEL thin film substrate in which the contact electrode 712 is not formed with vacuum evaporationo equipment. AuGe/Au and AuGe/nickel/Au are mentioned as an ingredient of these n electrodes. Moreover, in order to use said two electrodes as a low resistance ohmic electrode at this time, it annealed for several minutes to 30 minutes under the 350-400-degree C nitrogen-gas-atmosphere mind of temperature.

[0158] (4) After forming the formation contact electrode 712 of the mask for postetching, film deposition of the insulator layer which consists of SiON, SiNx, and SiO2 film with a CVD system, a sputtering system, etc. was carried out all over the front face of a near VCSEL thin film substrate in which the contact electrode 712 was formed, and the resist pattern was formed for this on the insulator layer with the usual photolithography, i.e., resist spreading, exposure, and development. And it is drawing 15 by etching an insulator layer by buffered fluoric acid, and removing a resist further. - As shown in (9), the mask 714 for postetching was formed. Etching of said insulator layer may be performed by the dry etching by fluorine system gas.

[0159] (5) number - by which even the edge of the AlAs layer 705 exposes formation of poststructure, next parts other than said mask 714 to the side face of the poststructure 715 with the dry etching system using chlorine-based gas -- Fukashi who is about ten micrometers -- dry etching -- carrying out -- drawing 15 - the poststructure 715 as shown in (10) was formed. At this time, the side face of the poststructure 715 is in the condition that the cross section of the cascade screen (reflector) of a VCSEL thin film substrate was exposed.

[0160] (6) After producing AlAs oxidation process post structure, it inserted into the annealing furnace immediately, the steam was introduced, and selective oxidation of an AlAs layer was performed from the postside face (drawing 16 - (11)). Annealing temperature at that time was made into about 350-400 degrees C. Moreover, said steam was introduced by carrying out bubbling of the 70-100-degree C hot water in a hot water tank with nitrogen carrier gas, and conveying it in a furnace. Although high AlGaAs and the AlAs layer of aluminum presentation change to an aluminum oxide (AlxOy) by performing

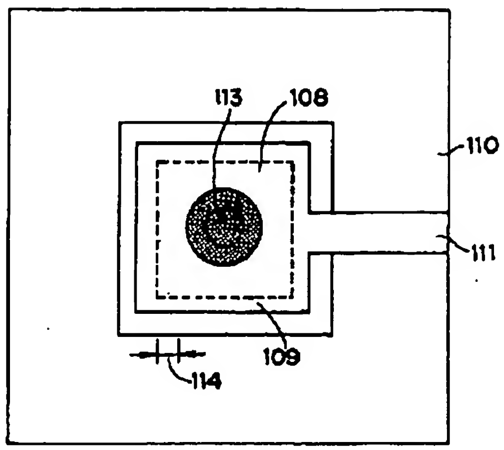
steam oxidation, the oxidation by which only an AlAs layer goes [the direction of an AlAs layer] to a postcore from a postside-attachment-wall edge alternatively since the oxidation rate is overwhelmingly quick compared with AlGaAs advances, and the AlxOy layer 716 is formed. Here, only request size can leave the AlAs layer 715 to a postcenter section by controlling annealing time amount. Said AlxOy layer 716 has small electrical conductivity to the degree of pole, and since the AlAs layer 715 has large electrical conductivity, it can make it the structure where a current flows only in the AlAs layer 715 left behind to the core of poststructure.
[0161] (7) Drawing 16 after performing AlAs oxidation at the process of the film deposition above (6) of an interlayer insulation film - As shown in (12), the whole post was completely covered with the interlayer insulation film 717 which consists of SiO2, SiON, SiNx, etc. This is for preventing deterioration of the oxidizing zone by the porous AlxOy film being placed in the condition of having exposed to the edge of a postside attachment wall in order to reinforce the fall of the post [itself] produced by having permuted most AlAs layers by the porous AlxOy film on the strength.
[0162] (8) It is drawing 16 by carrying out patterning and etching with formation and also photolithography of a contact hole. - As shown in (13), the contact hole 718 for making the contact electrode which is the lower layer of the protective coat and interlayer insulation film in the poststructure upper part ground p wiring electrode was opened. Etching by drug solutions, such as buffered fluoric acid (BHF), and dry etching can perform etching.
[0163] (9) On an interlayer insulation film 717, connect with a contact electrode, form p wiring electrode 719 at the formation last of p wiring electrode, and it is drawing 16 . - The perpendicular resonator mold face luminescence semiconductor laser equipment of this invention which has the cross-section structure shown in (14) was produced. the lift-off method which said p wiring electrode 719 forms a resist pattern with the usual photolithography, and exfoliates and forms a resist after carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, and a resist pattern is formed with the usual photolithography on Au film, and it can form suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. may be used for p electrode material.
[0164] As mentioned above, contact resistance was low, and the field luminescence semiconductor laser equipment of a reliable perpendicular resonator mold was able to be produced, without having obtained the laser beam of high power and moreover a laser output declining with time amount by impressing a low battery.
[0165] (Example 6) As it was the following, the perpendicular resonator mold face luminescence semiconductor laser equipment (the second mode of this invention) which has the same structure as drawing 17 was produced.
[0166] On the Si dope (Nd=1x1018cm-3) n mold GaAs semi-conductor substrate 101 The Si dope (Nd=1x1018cm-3) n mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As distribution Bragg reflection mirror 102 of 40.5 periods (DBR layer), The undoping lambdaaluminum0.6Ga0.4As spacer layer 105 and the 3-fold quantum-well aluminum0.11Ga0.89 As/aluminum0.3Ga0.7As barrier layer 103, The p mold AlAs layer 104 which consists of a Zn dope (Na=7x1017cm-3), and has oxidation field 104A and non-oxidizing field 104B, Zn dope (Na=7x1017cm-3) p mold aluminum0.3Ga0.7 As/aluminum0.9Ga0.1As of 30.5 periods DBR layer 106, Laminating formation of the Zn dope (Na=1x1019cm-3) p mold GaAs layer (contact layer) 107 was carried out at this order (an Si dope n mold GaAs buffer layer is un-illustrating).
[0167] furthermore, the protective coat 109 which consists of SiOxNy directly in contact with this layer forms on the GaAs contact layer 107 -- having -- this protective coat 109 top -- lapping -- the abbreviation for a protective layer -- the contact electrode 108 which has the opening 113 for laser outgoing radiation only in a flat field is formed. Furthermore, it has the mask 115 which consists of SiNx. In addition, opening 113 is completely covered by the SiON protective coat 109. The path of said protective coat 109 is regulated by the desired path with the contact electrode 108.
[0168] Moreover, it has a contact hole 114, on the contact electrode 108, as an interlayer insulation film 110 covers poststructure, it is formed, and on this interlayer insulation film, the wiring electrode 111 is

formed in contact with said contact electrode 108. The wiring electrode 111 has touched in the flat surface field 114 on a contact electrode, i.e., a contact hole. The front face of the contact layer 107 of the field is covered with the contact electrode 108, and the contact layer is not exposed in said contact hole 114.
[0169] Below, the example is explained using drawing 18 -20 about the concrete production approach of the AlAs oxidation type VCSEL concerning the second mode of this invention.
(1) the production example 4 of a VCSEL thin film substrate (semi-conductor substrate) -- the same -- carrying out -- MOVPE -- law -- drawing 18 - the VCSEL thin film substrate as shown in (1) was produced.
[0170] (2) Film deposition of the SiOxNy was carried out to the field which serves as a laser beam window on the front face of the contact layer 807 which is the outermost layer of the VCSEL thin film substrate produced from the production above of a protective coat by the CVD method or sputtering (protective coat formative layer; un-illustrating). Then, a resist pattern is formed by the usual photolithography, SiOxNy is etched by the wet etching and dry etching using buffered fluoric acid (BHF) etc., a resist is exfoliated further, and it is drawing 18 . - As shown in (2), protective coat 811B of a desired configuration was formed. Since the thickness of protective coat 811B was etched a little at the time of next contact hole formation, it pondered etch selectivity with the ingredient kind of an interlayer insulation film beforehand, and set it as the thickness from which the reflection factor of the reflecting mirror which consists of protective coat 811B, a semi-conductor multilayers DBR reflecting mirror 806 of the second conductivity type, and a contact layer 807 serves as the maximum mostly.
[0171] (3) production of p contact electrode which has opening, next drawing 18 - it is shown in (3) -- as -- said MOVPE -- p contact electrode 809 which has the opening 810 for laser outgoing radiation on the front face of the contact layer 807 which is the outermost layer of the VCSEL thin film substrate produced by law was produced by the following approach. the lift-off method which exfoliates and carries out electrode formation of said resist after this p contact electrode forms a resist pattern in the front face of the contact layer 807 which is the outermost layer with the usual photolithography and carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, a resist pattern is formed with the usual photolithography on this Au film, and it can produce suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. can also be used as an ingredient of said p contact electrode.
[0172] (4) n rear-face electrode film deposition -- here -- drawing 18 - as shown in (4), film deposition of the n electrode 812 was carried out to the front face of a near VCSEL thin film substrate in which protective coat 811B is not prepared with vacuum evaporationo equipment. Then, annealing treatment was performed to the two electrodes of p and n for several minutes - 30 minutes under the 350-400-degree C nitrogen-gas-atmosphere mind of temperature, and it considered as the ohmic electrode.
[0173] (5) In order to consider as the poststructure of the shape of the film deposition of the mask material for postetching, and a patterning column of the mask by etching, film deposition of the SiNx film was carried out as a dry etching mask by the CVD method or sputtering all over the front face of a near VCSEL thin film substrate in which protective coat 611B etc. was prepared. Then, the resist was further formed by the usual photolithography on this SiNx film, patterning was performed by the wet etching using fluoric acid system etchant by having used this resist as the mask, the resist was exfoliated, and the postetching mask 813 was formed (drawing 19 - (5)).
[0174] (6) number - to which even the edge of the AlAs layer 805 exposes formation of poststructure, next parts other than said etching mask 813 with the dry etching system using chlorine-based gas -- Fukashi who is about ten micrometers -- dry etching -- carrying out -- drawing 19 - the poststructure 814 as shown in (6) was formed. At this time, the cross section of the cascade screen of a VCSEL thin film substrate is exposed to a postside face.
[0175] (7) After producing AlAs oxidation process post structure, it inserted into the annealing furnace immediately, the steam was introduced, and selective oxidation of an AlAs layer was performed from the postside face (refer to drawing 19 -(7)). Annealing temperature at that time was made into about 350-400 degrees C. Moreover, said steam was introduced by carrying out bubbling of the 70-100-degree

C hot water in a hot water tank with nitrogen carrier gas, and conveying it in a furnace. Although high AlGaAs and the AlAs layer of aluminum presentation change to an aluminum oxide (AlxOy) by performing steam oxidation, the oxidation by which only an AlAs layer goes [the direction of an AlAs layer] to a postcore from a postside-attachment-wall edge alternatively since the oxidation rate is overwhelmingly quick compared with AlGaAs advances, and an oxidizing zone 815 is formed. Here, only request size can leave the AlAs layer 805 to a postcenter section by controlling annealing time amount. Said AlxOy layer 815 has small electrical conductivity to the degree of pole, and since the AlAs layer 805 has large electrical conductivity, it can make it the structure where a current flows only in the AlAs layer 805 left behind to the core of poststructure.
[0176] (8) Drawing 19 after performing AlAs oxidation at the process of the film deposition above (7) of an interlayer insulation film - As shown in (8), film deposition of the SiNx film was carried out by the CVD method or sputtering, and the whole post was completely covered with the interlayer insulation film 816 which consists of SiNx. This is for preventing deterioration of reinforcement of a fall of the post [itself] produced by having permuted most AlAs layers 805 by the porous AlxOy film on the strength, and the porous AlxOy oxidizing zone 815 in the condition of having exposed to the edge of a postside attachment wall. SiO2, SiOxNy, etc. may be used as an interlayer insulation film.
[0177] (9) The interlayer insulation film 816 and the postetching mask 813 were etched by formation, next dry etching of a contact hole (refer to drawing 20 R>0-(9)). Dry etching conditions can etch an interlayer insulation film 816 and the postetching mask 813 alternatively, and choose conditions into which protective coat 811B is hardly etched.
[0178] (10) On an interlayer insulation film 816, connect with a contact electrode, form p wiring electrode 819 at the formation last of p wiring electrode, and it is drawing 20 . - The perpendicular resonator mold face luminescence semiconductor laser equipment of this invention which has the cross-section structure shown in (10) was produced. the lift-off method which said p wiring electrode 819 forms a resist pattern with the usual photolithography, and exfoliates and forms a resist after carrying out film deposition of Ti and the Au one by one -- or film deposition of Ti and the Au is carried out beforehand, and a resist pattern is formed with the usual photolithography on Au film, and it can form suitably by the approach of etching and carrying out pattern NINGU of Ti and the Au. AuZn/Au besides Ti and Au, Ti/Pt/Au, etc. may be used for p electrode material.
[0179] As mentioned above, contact resistance was low, and the field luminescence semiconductor laser equipment of a reliable perpendicular resonator mold was able to be produced, without having obtained the laser beam of high power and moreover a laser output declining with time amount by impressing a low battery.
[0180] (Example 7) After performing the process shown in drawing 18 R>(1) of 8-19 - (8) as well as an example 6, as an approach of forming a contact hole in the poststructure upper part of a VCSEL thin film substrate the process (drawing 20 -(9) - (10)) of (9) and (10) performed in the example 6 is shown below (9-a) -- it replaced with the process (refer to drawing 21) of - (9-b), and the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention was produced.
[0181] Below, the concrete production approach is explained using drawing 21 R> 1.
(9-a) The resist was formed on the formation 1 drawing 4 -this interlayer insulation film 816 of a contact hole as shown in (8), after covering the whole post with the interlayer insulation film 816 which consists of SiNx completely, patterning was carried out with photolithography, by using this resist as a mask, the center section of the interlayer insulation film of the poststructure upper part was etched into the configuration shown in drawing 21 - (9-a) using buffered fluoric acid (BHF) etc., and the beer 820 for contact hole formation was formed. Dry etching can also perform this etching. The postetching mask 813 may be etched into extent which protective coat 811B and the contact electrode 809 do not expose at coincidence in that case.
[0182] (9-b) The postetching mask 813 in the beer 820 for contact hole formation was etched by formation 2, then dry etching of a contact hole (refer to drawing 21 - (9-b)). Although conditions into which the postetching mask 813 can be alternatively etched into as dry etching conditions also in this case, and protective coat 811B is hardly etched are chosen, since thickness which performs dry etching

can be made small, over etching time amount can be shortened, the effect on a protective layer is reduced or the small etching conditions of etch selectivity can also be applied.
[0183] (Example 8) After performing the process shown in drawing 18 R>(1) of 8-20 - (9) as well as an example 6, as an approach of connecting with the contact electrode of the poststructure upper part of a VCSEL thin film substrate, and forming p wiring electrode 819 it is shown in drawing 22 -- as -- a contact electrode -- the abbreviation for a protective layer -- it was formed so that a flat surface front face might be contacted, and small opening of the diameter of opening regulated with these p wiring electrodes was formed. Since it forms in the culmination of a manufacture process, p wiring electrode can also be formed so that the variation in the process before it may be amended. Drawing 2222 is drawing showing the top face and a side cross section as an example of the perpendicular resonator mold face luminescence semiconductor laser equipment of this invention.
[0184] Like the example 6, when contact resistance impressed a low battery low, the laser beam of high power was obtained and the field luminescence semiconductor laser equipment of the reliable perpendicular resonator mold with which a laser output moreover does not decline with time amount was able to be produced.
[0185] (Example 9) the field where the end of the side which forms opening of the contact electrode 108 is flat as an approach of forming a contact electrode in the poststructure upper part of a VCSEL thin film substrate in the same process (drawing 18 R>(1) of 8-20 - (10)) as an example 6 as shown in drawing 23 -- not but, the contact electrode was formed so that it might be located in inclination field (taper field) 116b of a protective coat 109.
[0186] abbreviation to which the thickness of a protective coat becomes thick by the taper field 116a incline in the reflector which contains the DBR layer 106 (semi-conductor multilayers reflecting mirror of the second conductivity type) and the contact layer 107 in opening 113, and the protective coat 109 of the contact electrode 108 in the perpendicular resonator mold face luminescence semiconductor-laser equipment of this invention shown in drawing 23 and which it is alike, and it follows, and a reflection factor becomes large, and exposes -- it set up so that a reflection factor may serve as max in a flat surface field 115. It can narrow rather than opening which formed the waveguide of the longitudinal direction of laser by this using the contact electrode substantially. Moreover, a desired beam diameter and oscillation mode can be chosen by controlling the taper angle and configuration of a taper field suitably.
[0187] (Example 10) As it was the following, the perpendicular resonator mold face luminescence semiconductor laser equipment (the second mode of this invention) which has the same structure as drawing 24 was produced. Protective coat formative layer 109' is made to come to exist in formation and coincidence of a protective coat to this field by this example to the example 6 which made the postetching mask exist in the field which is not covered with the protective coat 109 and the contact electrode 108 of the poststructure upper part of a VCSEL thin film substrate.
[0188] Below, the example is explained using drawing 25 and drawing 26 about the concrete production approach of the AlAs oxidation type VCSEL concerning this example (the second mode).
(1) the production example 6 of a VCSEL thin film substrate (semi-conductor substrate) -- the same -- carrying out -- MOVPE -- law -- drawing 25 - the VCSEL thin film substrate as shown in (1) was produced.
[0189] (2) patterning **** of the mask by the film deposition of the mask material for postetching, and etching, and MOVPE -- the whole surface surface of the contact layer 907 which is the outermost layer of the VCSEL thin film substrate produced by law -- by the CVD method or sputtering, the SiNx film was carried out as the protective coat formative layer, the laminating of the SiOxNy film was further carried out as a dry etching mask on this layer, and film deposition was carried out. Then, in order to process column-like poststructure, the resist was further formed by the usual photolithography on said SiNx film, patterning was performed by the wet etching using fluoric acid system etchant by having used this resist as the mask, and the laminating section of the postetching mask 913 exfoliated and patternized in the resist and the protective coat formative layer 911 was formed (drawing 25 - (2)).
[0190] (3) It is drawing 25 like (6) of an example 6 about parts a formation of poststructure, and AlAs

acid chemically-modified degree, next other than etching mask 913. - The poststructure 914 as shown in (3) was formed. At this time, the cross section of the cascade screen of a VCSEL thin film substrate is exposed to a postside face. Then, by the same actuation as (7) of an example 6, after producing poststructure, it inserted into the annealing furnace immediately, the steam was introduced, and selective oxidation of an AlAs layer was performed from the postside face (refer to drawing 25 -(4)).
[0191] (4) Drawing 26 after performing film deposition AlAs oxidation of an interlayer insulation film - As shown in (5), film deposition of the SiOxNy film was carried out by the CVD method or sputtering, and the whole post was completely covered with the interlayer insulation film 916 which consists of SiOxNy film.
[0192] (5) On formation 1 interlayer insulation film 916 of a contact hole, the resist was further formed by the usual photolithography, the interlayer insulation film 916 and the postetching mask 913 were etched by dry etching by having used this resist as the mask, and the beer 920 for contact hole formation was formed (drawing 26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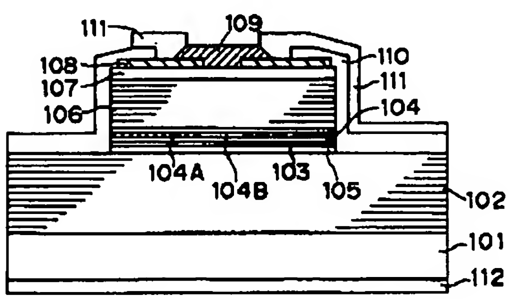
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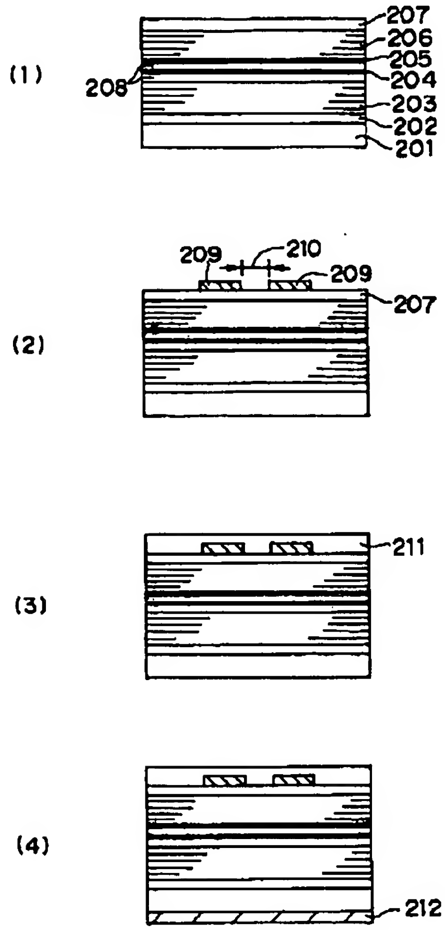
[Drawing 3]



[Drawing 4]

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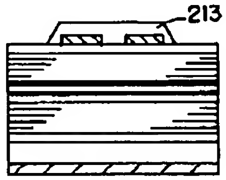

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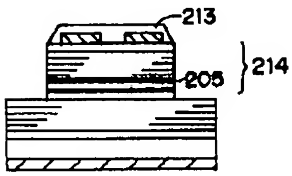

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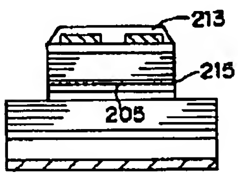

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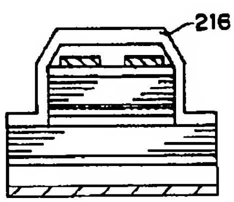
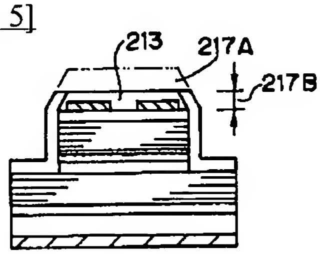
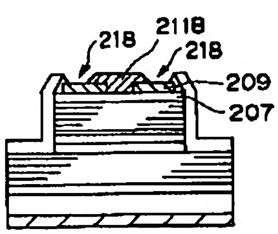
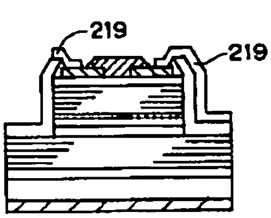


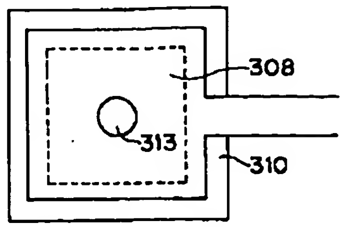
[Drawing 5]

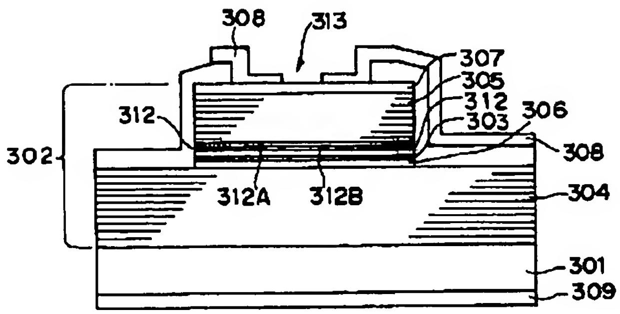
(9)


(10)


(11)


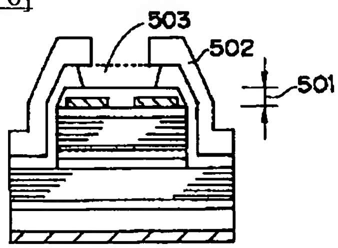
[Drawing 8]



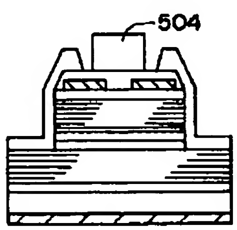


[Drawing 6]

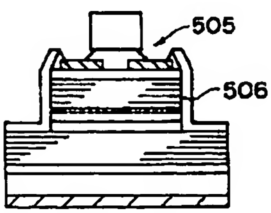
(9-a)



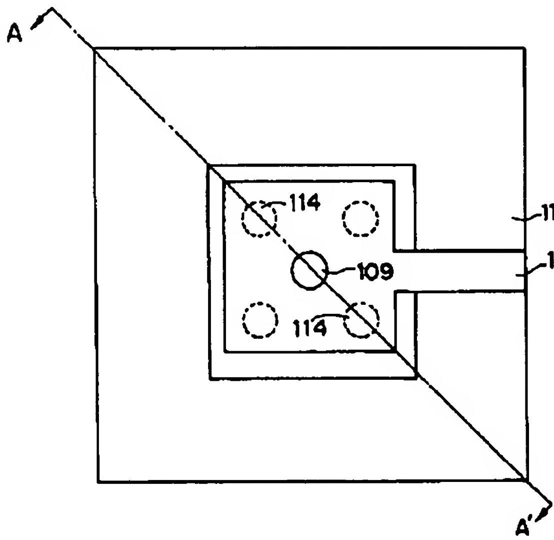
(10-a)

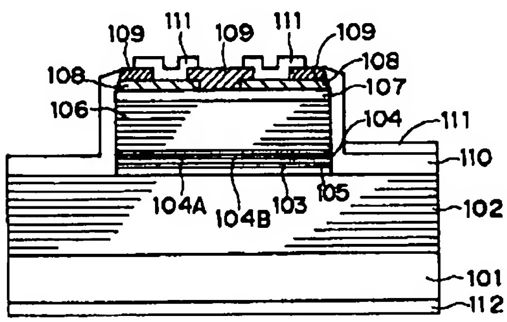


(10-b)



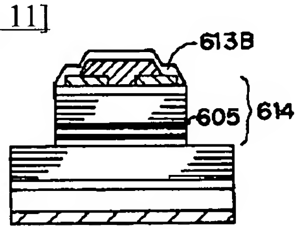
[Drawing 7]





[Drawing 11]

(8)



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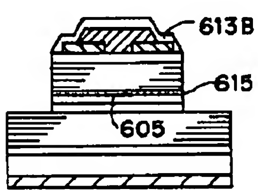

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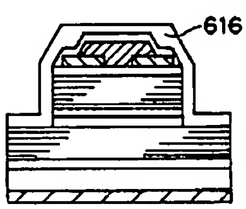
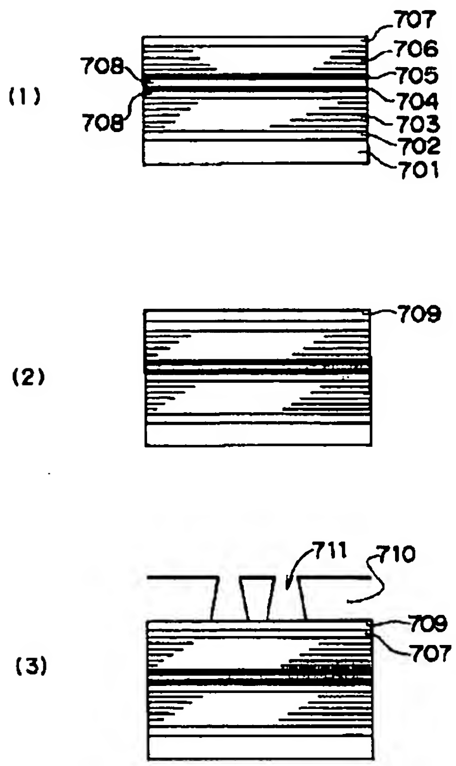
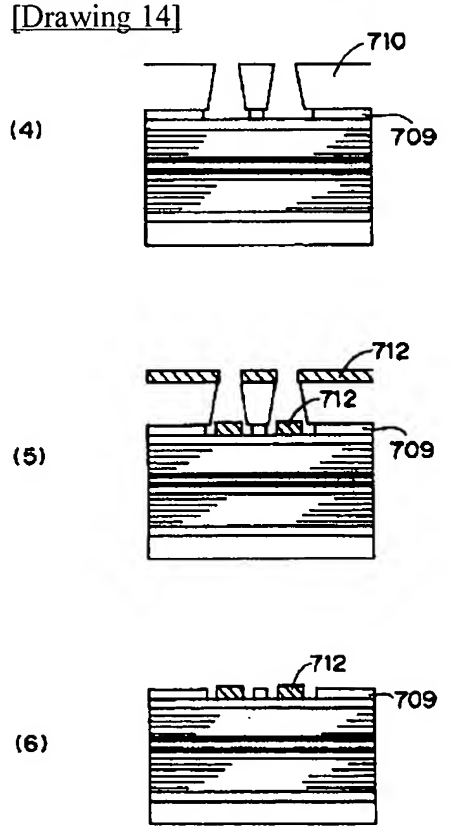


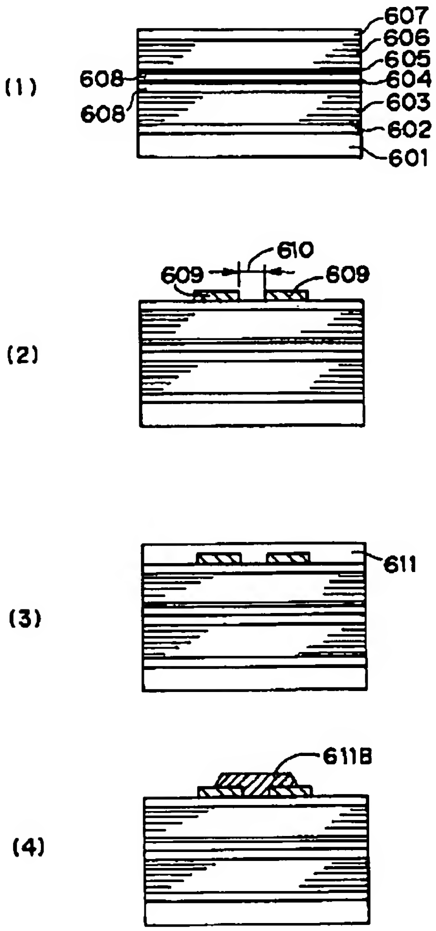
[Drawing 13]



[Drawing 14]

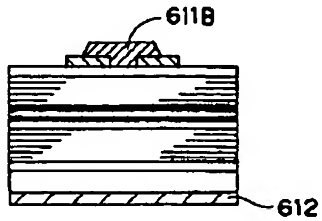


[Drawing 9]

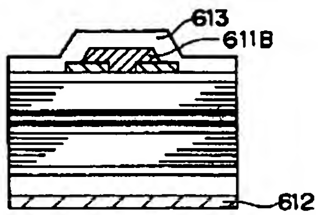


[Drawing 10]

(5)



(6)



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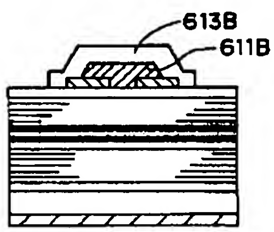
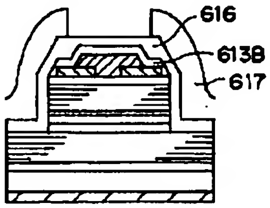


[Drawing 12]

(11)



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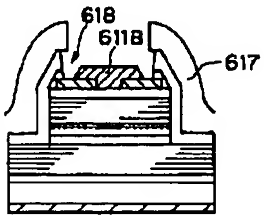

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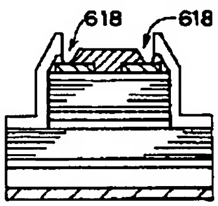

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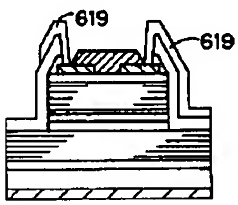
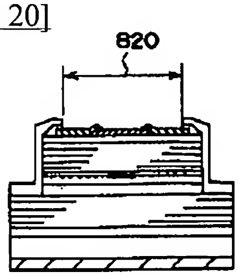


[Drawing 20]

(9)



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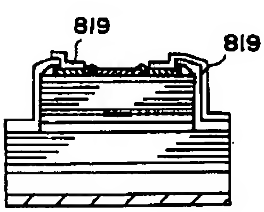
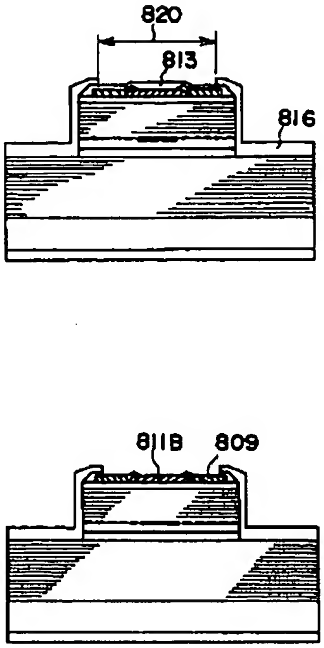


[Drawing 21]

(9-a)

(9-b)



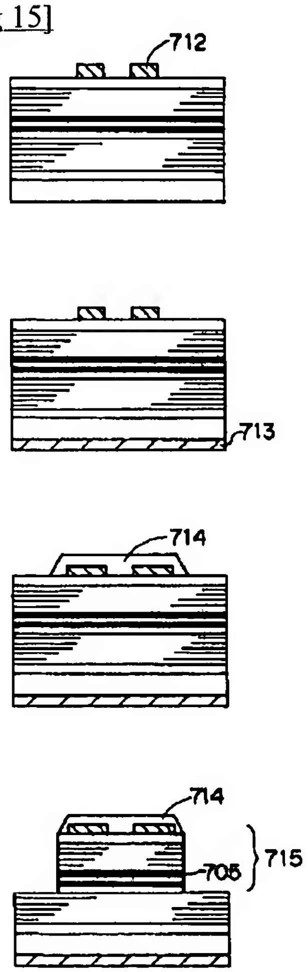
[Drawing 15]

(7)

(8)

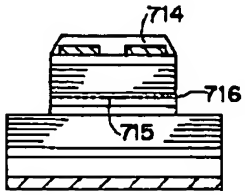
(9)

(10)

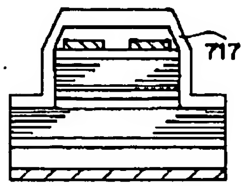


[Drawing 16]

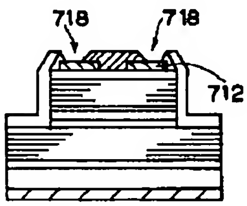
(11)



(12)



(13)



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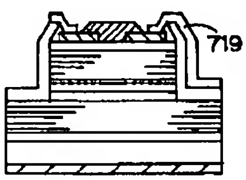
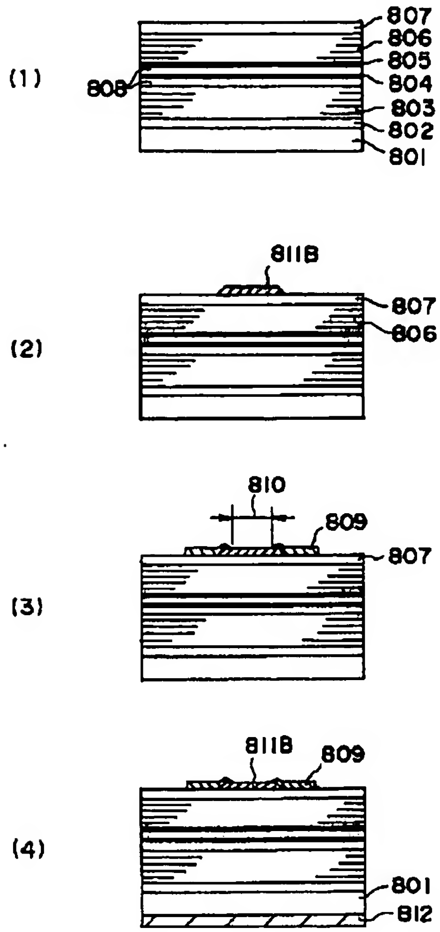


[Drawing 18]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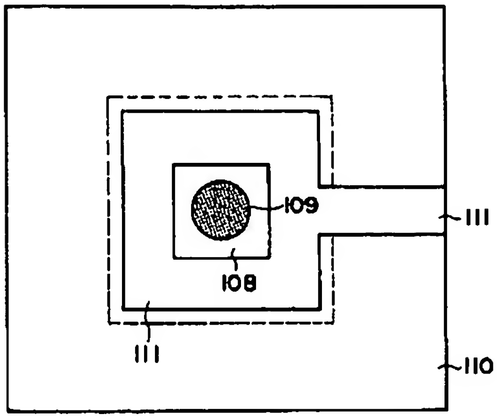
[Drawing 17]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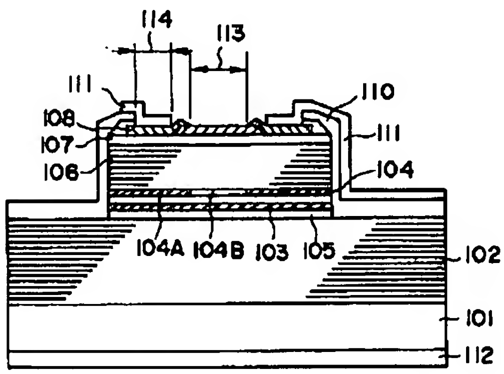
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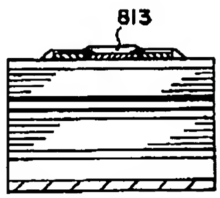
[Drawing 19]

(5)



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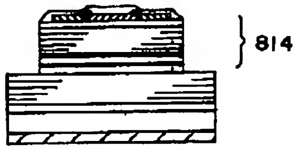

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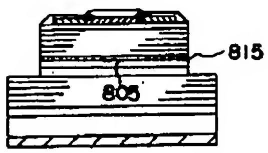

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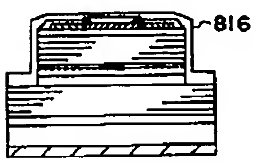
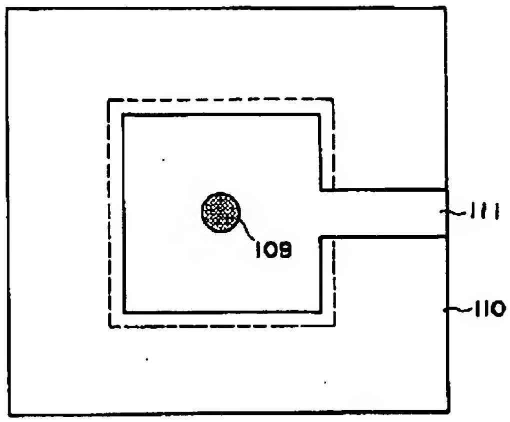
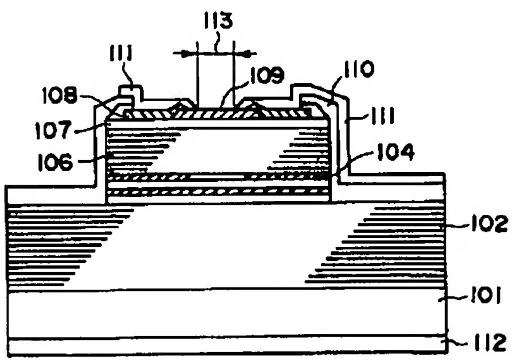
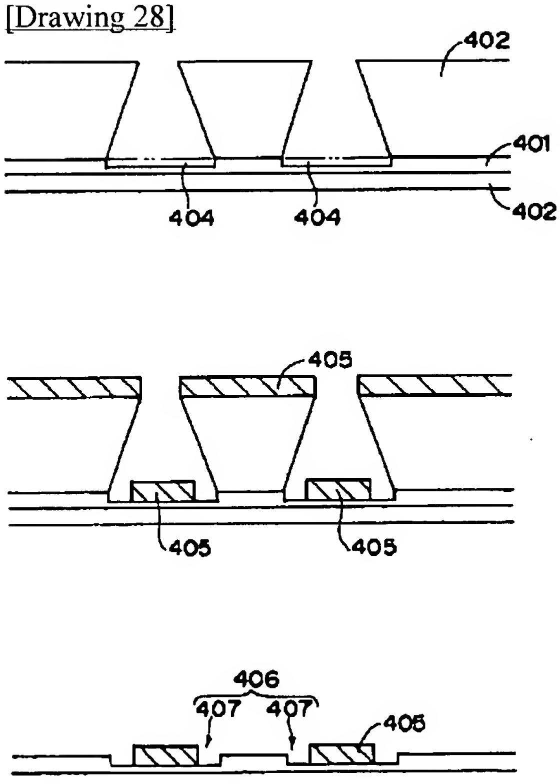


[Drawing 22]

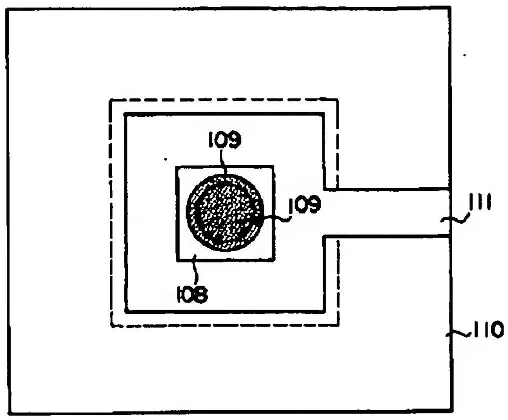


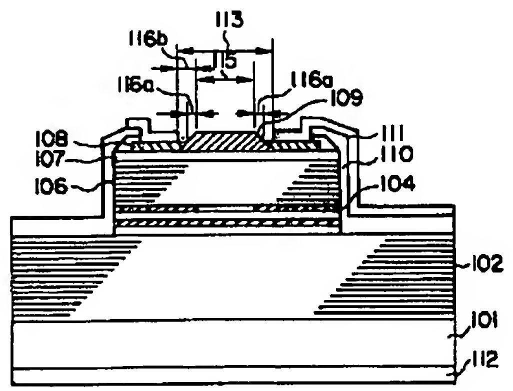


[Drawing 28]

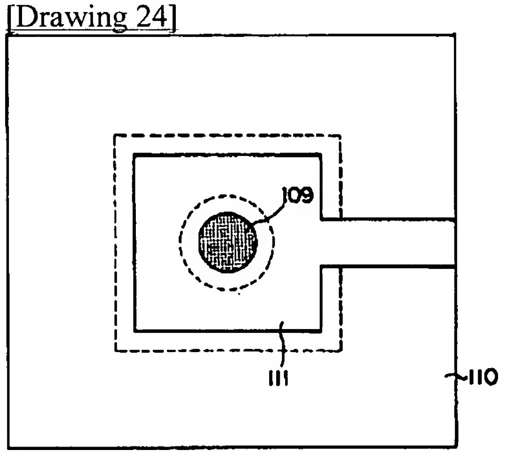


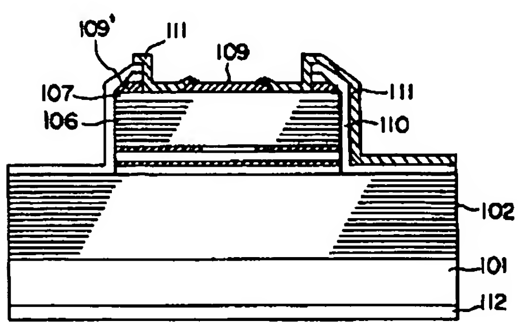
[Drawing 23]



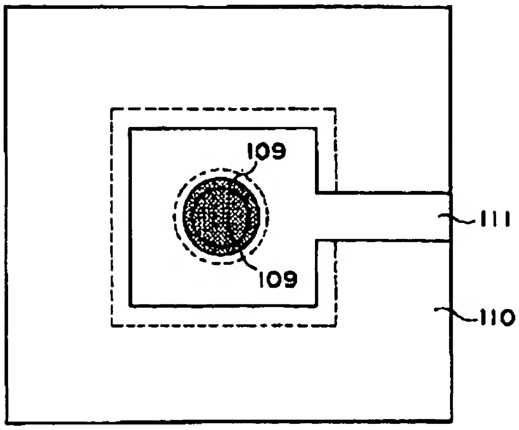


[Drawing 24]





[Drawing 27]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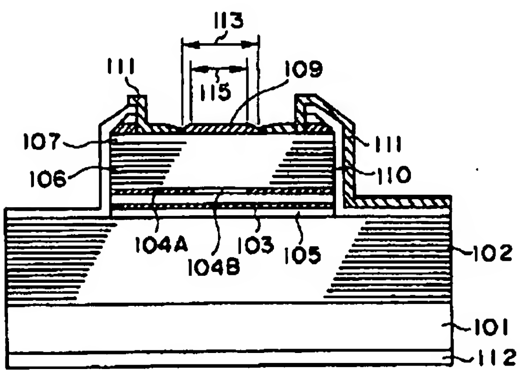
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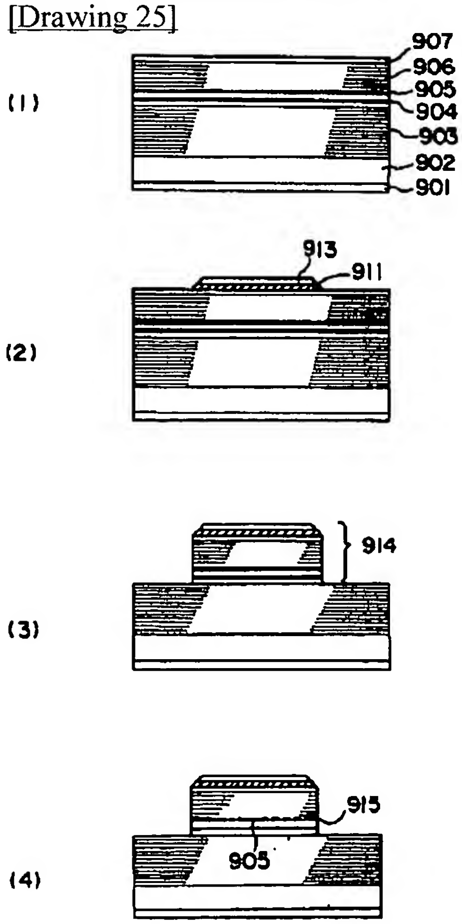
[Drawing 25]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[Drawing 26]